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UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey

of

Monroe County, Iowa

By

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Iowa Agricultural Experiment Station, in Charge

and

W. E. THARP
United States Department of Agriculture

Bureau of Chemistry and Soils

In cooperation with the Iowa Agricultural Experiment Station

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SOIL SURVEY OF MONROE COUNTY, IOWA

By C. L. ORRBEN, Iowa Agricultural Experiment Station, In Charge, and W. E. THARP, United States Department of Agriculture

COUNTY SURVEYED

Monroe County is in the southern part of Iowa, in the second tier of counties north of the Missouri-Iowa State line (fig. 1). Albia, the county seat, is located near the center of the county, about 70 miles southeast of Des Moines. The county is rectangular in shape, comprises 12 townships of 36 square miles each, and has a total area of 432 square miles, or 276,480 acres.

Monroe County has the characteristic erosional relief developed by dissection of a level plain. The tops of the ridges, rising to approximately the same elevation, roughly represent the surface of the plain before stream dissection brought it to its present condition. A comparatively narrow high divide extending from Lovilia southeastward through Albia and Moravia (in Appanoose County) divides Monroe County into two almost equal parts, and two narrow divides extend northeastward from Albia as branches of the main divide. The Wabash Railway follows the north-and-south divide, the Chicago, Burlington & Quincy Railroad follows one of the divides northeast of Albia, and State Road No. 59 follows the other.

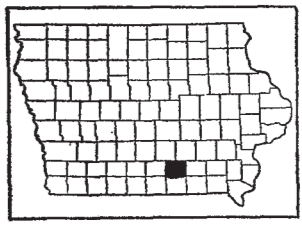

FIGURE 1.—Sketch map showing location of Monroe County, Iowa.

With the exception of the divides, the county is thoroughly dissected by streams. There are no large rivers, except the Des Moines which flows across the extreme northeastern corner, but the numerous large creeks and their tributaries reach every section. Most of the streams are intermittent, or become nearly dry during the summer. During 1930 and 1931, practically every stream, except Des Moines River, was dry. Small pools of water in the deeper pockets of some streams were kept at a constant level by seepage from the underlying gravelly strata at the bases of the slopes.

All the streams are cutting their beds deeper, the valleys are narrow and V-shaped with steep slopes, and the alluvial deposits along the streams are small. The flood plain of Cedar Creek, the largest stream except Des Moines River, in few places exceeds one-half mile in width. A few narrow low terraces have been built up, but their total area is small. The streams have considerable fall, and although much material is washed from the steep unstable slopes during each rain, it is not deposited along the narrow stream valleys but is carried out of the county to be laid down on some distant flood plain. Streams have so thoroughly dissected the entire county that drainage is well established and in the greater part is excessive. Rapid run-off from the steep slopes annually removes undeterminable quantities of soil material.

Cedar Creek enters the county from the west, flows eastward about 10 miles and thence meanders north by northwest into Marion County.

The streams in the eastern half of the county flow eastward, with deviations both to the north and south. From a point in the vicinity of Albia, drainage channels extend in every direction from the level upland plain.

The most rugged land is in the northwestern part, where the stream valleys are deep and narrow, the slopes steep, the ridges eroded and narrow, and erosion is still continuing to cut down the slopes and remove the tops of the ridges. Tributaries of the main streams extend back into the upland, sending small fingerlike drainage channels into every section. South of Tyrone the same condition exists but to less degree. The relief over the rest of the county is not so rugged, and although thoroughly drained, the slopes are longer and much more gentle, the ridges are more rounded, and in some places narrow flats remain along the tops of the ridges.

Elevations in different parts of the county indicate that the general slope is toward the north and east. Moravia, in Appanoose County, one-half mile from the county line, has an elevation of 1,001 feet above sea level; [1] Albia, 959 feet; Lovilia, 932 feet; Melrose, 871 feet; Tyrone, 839 feet; and Avery, 903 feet. The maximum difference in elevation is about 300 feet, from 677 feet along Des Moines River in the northeastern corner to 1,000 feet on the divide at the southern county line. Local differences in elevation in few places exceed 100 feet but may reach 150 feet.

When white settlers first entered Monroe County, they found two types of vegetation. The level divides, crests of ridges, or remnants of old divides supported a heavy cover of prairie grasses, and the stream valleys supported a sparse tree growth of cottonwood, willow, walnut, elm, butternut, basswood, sycamore, maple, and a few oak trees. The lower slopes of the ridges were covered by a heavy growth of oaks, hickory, ash, elm, boxelder, wild cherry, plum, and crab apple, and this timber growth extended somewhat more than halfway up the slope. Above this point hazelbrush, buckbrush, blackberry, and prairie grasses formed the cover. After the advent of the white man, much of the timber was removed for fuel and building material, or the land was cleared and used for crop production. Practically all the heavy timber has been removed. It has been replaced by a brushy straggly second growth, mainly of white oak, which has crowded out and smothered all other forms of vegetation, thereby materially detracting from the value of the land. Much of the land has been covered by trees for long periods, as evidenced by the light color of the surface soils, but in other areas where the tree growth was less heavy, or where the land was covered with hazelbrush and other shrubs, the surface soil layers are darker, although much lighter than the typical prairie soils formed under heavy grass cover. The present vegetation consists of trees on the lower slopes of even many of the smaller streams and a bluegrass cover on the slopes of the uncultivated areas.

The territory now known as Monroe County was purchased from the Sac and Fox Indians in 1842. It was opened for settlement in May 1843, the first settler locating along Des Moines River near Eddyville (Wapello County). In 1845, Monroe County was organized, named, and the county seat laid out on the present site of Albia which was originally called Princeton. Most of the early settlers

[1] GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U.S. Geol. Survey Bull. 274, ed. 4, 1,072 pp. 1906.

migrated to this county from the Eastern and Southern States. The foreign population was mainly German, Scandinavian, and Irish. With the development of the coal industry, the foreign population increased, the larger proportion coming from southern Europe.

The Federal census for 1930 gives the total population as 15,010, with 70.5 percent classed as rural. The average density of population in the rural districts is 24.5 persons a square mile. The same census reports the combined percentage of foreign-born whites and native whites of foreign parentage to be 18.8 percent of the total population. The small negro population has greatly diminished within the last decade. Albia, the county seat and only city, has a population of 4,425. Lovilia, with a population of 727, Hiteman with 650, Avery with 450, and Melrose with 417 are small towns and local trading centers.

The Chicago, Burlington & Quincy Railroad furnishes direct connection with the Chicago, Omaha, Ottumwa, and Des Moines markets. The Wabash Railway, Minneapolis & St. Louis Railroad, Southern Iowa Utilities Railway (electric), and Chicago, Milwaukee, St. Paul & Pacific Railroad also afford ready access to markets. Two paved trunk highways—United States Highway No. 34 and State Highway No. 60—provide excellent all-weather transportation facilities to points outside the county. The county and township roads are of earth construction, well graded, and dragged, and a few miles of the main county-road system have been surfaced with shale obtained from mine dumps scattered throughout the county.

Rural schools are located at 2-mile intervals, and graded and high schools are in the towns and villages. A few country churches are maintained, but with the advent of the automobile, their attendance has decreased in favor of the larger churches in the towns. Telephones and radios are considered necessities which keep the farmer informed on world activities, weather forecasts, and markets.

Although agriculture has again established itself as the principal means of obtaining a livelihood, during the period between 1900 and 1920 the coal industry afforded employment to thousands of rural workers, reaching its peak between 1910 and 1920, but since that time it has steadily declined. The entire county is underlain by coal deposits, the best of which have been worked. The coal veins range in thickness from a few inches to 8 feet, the better grades of coal being obtained from the thinner veins. Steam and electric hoists raise the coal to the surface, where it passes through the cleaning and breaking plants. Most of the coal mined is ground and sold as steam coal, and it is shipped by rail to various parts of Iowa and adjoining States. Trucks are used to transport lump coal from the mines to nearby towns for local consumption. Monroe County has been the leading coal-producing county of Iowa for several years. At present mines located near Rexfield, Hiteman, Avery, Albia, and Consol are in operation, and many slope mines and small shaft mines, which supply local communities with fuel, operate only during the fall and winter.

CLIMATE

The climate of Monroe County is healthful and well suited to general farming, as the temperature and the distribution of rainfall favor the growing of all crops common to the Corn Belt. The growing season is sufficiently long to mature late varieties of corn, and this,

in conjunction with a normally abundant supply of moisture and sunshine, renders the climate ideal for grain production. The mean annual precipitation as recorded at Albia is 33.16 inches, about 50 percent of which falls during May, June, July, and August. Spring rains occasionally interfere with the seeding of small-grain and corn planting, but these stormy periods are of short duration, and the delay is not serious. October and November are comparatively dry months which favor the maturing and drying of the corn crop. Fall rains seldom seriously affect harvesting of this crop. Droughts of long duration are uncommon, the longest on record occurring during 1930 and 1931 when crops were seriously affected by the extended dry period.

Mean seasonal temperatures range from 24.8° F. for the winter months to 72.9° for the summer months. Periods of extreme cold during the winter, accompanied by high winds and snowstorms, are of short duration, but during these cold periods, provision must be made to shelter the livestock. The summers are generally pleasant, with a range in temperature from 60° to 113°. The excessive heat waves are usually followed and broken by electrical storms. Hail may accompany these storms and sometimes causes local crop damage.

The average date of the last killing frost is April 29, and the latest recorded is May 25. The earliest recorded killing frost is September 13 and the average date of the earliest is October 9. The average frost-free season includes a period of 163 days, which is sufficiently long to mature all crops grown. The grazing season covers a period of about 250 days.

Table 1, compiled from records of the Weather Bureau Station at Albia, gives a representative summarization of the normal monthly, seasonal, and annual temperature and precipitation.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Albia, Monroe County, Iowa*

[Elevation 959 feet]

Month	Temperature	Precipitation		
	Mean	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1905)
	°F.	*Inches*	*Inches*	*Inches*
December	27.2	1.16	0.30	1.08
January	21.7	1.07	1.48	1.04
February	25.4	1.33	.48	1.87
Winter	24.8	3.56	2.26	3.99
March	37.4	1.96	.35	2.41
April	50.6	3.20	2.02	4.72
May	62.0	4.48	3.99	4.76
Spring	50.0	9.64	6.36	11.89
June	70.3	4.54	1.72	9.06
July	74.9	3.83	1.57	7.08
August	73.4	3.66	.55	7.87
Summer	72.9	12.03	3.84	24.01
September	66.1	3.99	3.02	4.92
October	53.8	2.31	.30	4.17
November	38.7	1.63	.52	2.47
Fall	52.9	7.93	3.84	11.56
Year	50.1	33.16	16.30	51.45

AGRICULTURAL HISTORY AND STATISTICS

The first white settlers entering the county established their homes near Des Moines River in the vicinity of Eddyville. Following this, the land along Miller Creek, Grays Creek, and Avery Creek was acquired, and as the movement continued westward, the area traversed by Cedar Creek was settled. The land adjacent to the streams supported a heavy timber growth, the rougher areas being entirely timbered, which supplied building material and fuel, and the streams afforded an abundant water supply. After these choice parcels of land were occupied, it was necessary for the pioneers to select sites farther from the main streams, along the numerous small tributary streams which dissected the original level plain, where the lower slopes of the hills were more or less tree covered, the upper slopes brush covered, and the crests of the hills and narrow divides in prairie.

The water supply furnished by intermittent streams was uncertain, making it necessary to sink wells in the valleys, and some of the settlers constructed dams across small gullies to trap and conserve the surface water for the use of livestock during the dry summer months. The last land to be occupied was the flat prairie land, which until this time served as common pasture land for all livestock. Only small patches of land were placed under cultivation, and garden crops, wheat, and corn, in sufficient quantities to supply the home needs, constituted the extent of the farming practices. Livestock roamed the wooded and prairie lands, fattening on the luxuriant grasses and the nuts and acorns of the forests. The forests abounded in wild game, and the streams teemed with fish. Hides and furs served as articles of barter for commodities needed in the home. The streams furnished a means of travel, but the transportation of surplus goods was limited, and the trade in livestock and grain was small.

With an increase in population, the advent of the railroads, and the passing of herd laws controlling livestock, the field of agriculture was opened. Practically all the land was acquired by 1870, and wheat became the main crop. The large acreage of land suitable only for pasture gave an impetus to the raising of beef cattle and the maintaining of dairy herds.

After agriculture became firmly established, the coal industry became important as a source of income. The first mines were small, furnishing fuel to small neighborhoods, but the railroads soon changed this condition, and large mines in several parts of the county were developed to such an extent that by 1900 coal mining had overshadowed agriculture, and farming became of secondary importance. Land not suitable for cultivation because of its run-down condition, neglect of gully erosion, and sheet wash was allowed to grow up in grass and brush. Many miners acquired small tracts of land near mines, farmed them when possible, and utilized the crops mainly in the home. With the abandonment of many of the larger coal mines within the last decade, attention has again reverted to agriculture as the main source of livelihood.

Of the total area of 276,480 acres (according to the 1930 census report) in Monroe County, 253,476 acres are in farms, and the remaining acreage is occupied by towns, public roads, and railroads. The number of farms is 1,695, and the average size is 149.5 acres. Approximately 46.3 percent, or 117,274 acres of the total land in

farms, was utilized as crop land in 1930, and the remaining 53.7 percent consists of woodland, waste land, and permanent pasture land. Of the area in farms in 1930, corn occupied 19.4 percent, oats 8.1 percent, hay 13.5 percent, and wheat, timothy for seed, barley, soybeans, rye, potatoes, and miscellaneous crops occupied much smaller percentages.

Table 2 shows the acreages and yields of the principal crops in Monroe County, as reported by the Federal census for the years 1879, 1889, 1899, 1909, 1919, and 1929.

TABLE 2.—*Acreages and yields of the principal crops in Monroe County, Iowa, in stated years*

Year	Corn		Oats		Hay	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Tons*
1879	47,691	1,754,539	14,128	462,304	28,378	40,113
1889	36,047	1,470,304	14,439	501,224	50,041	65,569
1899	50,377	1,579,450	11,746	327,820	40,961	48,187
1909	43,487	1,146,267	8,694	202,569	47,299	62,074
1919	42,269	1,448,964	17,181	323,159	28,516	34,681
1929	41,686	1,302,083	19,071	453,343	34,121	33,991

Year	Wheat		Rye		Potatoes	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
1879	9,494	101,261	1,288	15,805	----------	60,169
1889	1,625	19,818	1,400	20,274	689	57,424
1899	242	2,750	1,507	15,460	696	56,892
1909	5,797	88,482	148	1,621	668	40,742
1919	22,229	361,838	759	8,247	262	10,133
1929	3,737	55,764	483	5,733	350	25,169

Corn is the principal crop grown. Oats are grown mainly to supplement corn in the cropping system and to serve as a nurse crop for the hay mixture. On a large proportion of the land, continued corn and small-grain cropping may decrease yields, through lowering the supply of plant nutrients and humus and through deterioration of the fields by surface erosion on the more sloping areas. Land of this kind is seeded to timothy and clover meadows to be used both as pasture and hay land. The hay acreage is exceedingly high in comparison to the amount of crop land.

The exceptionally large acreage of hilly land, suitable only for permanent pasture, affords grazing through the entire growing season, although much of the rougher land is heavily wooded and supplies but little feed for livestock. Cut-over land rapidly grows up to brush and second-growth oak and scrub oak so dense as to prevent any grass cover from gaining a foothold. Land in this condition is used as sheep pastures to some extent, but it is, in general, regarded as practically useless for any agricultural purpose.

This county has always been well stocked with cattle, hogs, and sheep. Table 3 gives the number of different kinds of livestock as reported by the Federal census and shows the extent of the livestock industry for the last three decades.

TABLE 3.—*Number of livestock in Monroe County, Iowa, in stated years*

Year	Hogs	Cattle	Horses	Mules	Sheep	Chickens
1910	28,487	32,724	10,001	889	7,433	[1] 143,429
1920	32,263	27,291	8,619	1,237	16,228	175,037
1930	42,289	25,565	5,655	1,141	22,832	181,726

[1] All poultry.

The county is well adapted to the production of livestock. The raising and feeding of beef cattle has provided one of the principal sources of income since the county was first settled, as the large areas of hilly land suitable only for pasture afforded good grazing, and the tillable ridges and gentle slopes supplied sufficient grain for fattening rations and for carrying the breeding animals through the winter. The supply of grain, however, is limited on many farms, and the operators depend on wintering their livestock mainly on roughage consisting of a mixture of timothy and clover hay. The cattle are turned into the cornfields after the grain is harvested, thereby conserving the supply of hay for periods of bad weather during the winter when cattle must be given shelter.

Some years ago it was not uncommon to see large herds of Hereford, Angus, and Shorthorn cattle grazing on extensive bluegrass pastures, but at present, herds of good breeding cattle are smaller and less numerous, as most farmers consider it more profitable to purchase feeders, either in nearby localities or on the open market, than to maintain herds of breeding animals. During the last 2 years the number of beef cattle has noticeably decreased, mainly because of the uncertain market conditions and low prices, and many farmers have turned to methods whereby they may receive quicker returns.

In recent years more attention has been given to dairying. The introduction of good-grade cows, purebred sires, better equipment for handling and housing the cattle, silos, and improved methods of feeding to insure high milk production has made dairying much more profitable. The sale of milk and cream furnishes a regular weekly income and has shown greater profits during the period of low prices than any other branch of the farm industry. The farmers maintaining dairy herds as the principal source of income keep from 15 to 25 cows, and almost every farmer has a few milk cows. The larger dairy farms are located near the larger towns where regular routes are established, and other dairymen sell their products to local creameries in the towns or to truckers who cover regular routes from 3 to 5 times a week. Holstein-Friesian, Guernsey, and Jersey, or grades of these breeds are preferred.

Hog raising has always been important, and the tendency in recent years has been toward raising hogs instead of beef cattle because of the ability of the raisers to increase the size of the herd very rapidly and because of the short time required to place the finished animals on the market as compared to cattle. Brood sows are selected from the young animals each year, and sires are purchased annually to head the herd and improve the stock. Duroc-Jersey, Hampshire, Poland China, and crosses of these breeds are the most popular.

Poultry raising, formerly regarded as a minor side line on the farms, has become a large factor in contributing to the farm income. Baby chicks are purchased from hatcheries, fed until they attain a weight of 2½ or 3 pounds, and then sold. The male birds and undesirable pullets are culled and sold, and the rest are kept for egg production. Poultry and produce houses located in the towns receive most of the live poultry and eggs from the farms, although a few independent buyers tour the county, purchasing live poultry and eggs to be trucked to the Chicago market.

Horses and mules furnish the greater part of the farm power, although tractors are used to some extent on farms where the tillable acreage is large. In 1930 there were 164 tractors on the farms.

Sheep and goats are pastured in the rougher areas where the bluegrass has been crowded out by brush and weeds. Goats are pastured on cut-over land in order to kill the sprouts from stumps on land to be cleared and placed under cultivation.

All the feed consumed is not produced on the farms where fed. Approximately 56 percent of the total number of farms reported purchasing additional feed in 1929. The total expenditure was placed at $240,632, or an average of $252.23 a farm reporting.

Only 5.6 percent of the farms reported the use of fertilizer, with an average expenditure of $53.72 a farm. This includes both limestone and commercial fertilizers. The use of limestone on acid soils is becoming more general, since it has been shown that alfalfa and sweetclover can be successfully grown on well-limed soils. Phosphates are used on cornland to some extent.

Most of the farm labor is supplied by the farmer and his family, but extra help is required during haying, small-grain harvesting, and corn-husking periods. The help is paid on a daily wage basis for haying and harvesting work, and corn husking is done mainly by hand, the pickers receiving from 3 to 6 cents a bushel, depending on wage scales during different years. Help hired on a monthly basis receives from $25 to $40. The supply of labor at present is much greater than the demand, and competent help can be obtained at low wages.

The average size of the farms is 149.5 acres. The range in size is from 10 acres—most of which farms are operated by coal miners—to more than 1,000 acres. The large farms are located in the hilly sections where woodland and grassland furnish good grazing for cattle.

The greater proportion, 66 percent, of the farms are operated by the owners; tenants operate 33.2 percent and managers 0.8 percent. Tenant farms are rented mainly on a share basis, whereby the landlord receives one-half of the corn, two-fifths of the small grain, and cash for hay and pasture land. The stock-share plan calls for equal division of the farm income, with the landlord furnishing the land, paying the taxes, and supplying one-half of the livestock. To offset this expense, the tenant furnishes the labor and equipment necessary to operate the farm on an efficient basis. Extra labor for building fences or for repairs around the farmstead must be paid by the landlord. Cash rents range from $1 to $8 an acre, depending on location, fertility of the farm, and amount of tillable land.

Table 4 shows the number, size, value, tenure, and improved land per farm for the census period from 1880 to 1930.

TABLE 4.—*Number of farms, size, improved land, and tenure of farms in Monroe County, Iowa, in stated years*

Year	Number of farms	Average size	Improved land per farm	Operated by—		
				Owner	Tenant	Manager
		Acres	*Acres*	*Percent*	*Percent*	*Percent*
1880	1,653	145.0	103.0	80.2	19.8	0.0
1890	1,639	146.0	101.0	81.2	18.8	.0
1900	1,987	132.0	91.1	71.3	27.8	.9
1910	1,917	134.6	101.1	71.5	27.5	1.0
1920	1,793	138.1	99.9	70.3	28.5	1.2
1930	1,695	149.5	66.4	66.0	33.2	.8

Practically every farm is equipped with modern labor-saving machinery, including plows, disks, harrows, corn planters, cultivators, binders, hay loaders, and mowers. A few corn pickers have been used in recent years to harvest the corn crop. Small-grain threshing is done either by privately owned outfits or group-owned machines. Corn binders are used by those farmers who shock their corn and feed the whole plant to cattle during the winter.

The farmsteads are conveniently located and include barns, hog houses, poultry houses, and shelter of some kind for all the livestock, although many of the buildings have been allowed to fall into poor repair, and many farms have become so badly depreciated and run down that they have been abandoned. On farms located in those sections where there is a large percentage of good tillable land the homes are well kept and the outbuildings are in good repair.

SOILS AND CROPS

Monroe County lies within the prairie region. As temperature and rainfall are nearly uniform throughout the county, these are not factors in determining the kind of crops that are grown in different places, but soil differences exert considerable influence on crop production, and the kind of soil on a particular farm largely determines the agricultural practices and type of farming followed.

The agriculture of Monroe County, and of the State as a whole, is based on the production of corn, and the ability to produce corn economically is a large factor in determining the value of the soil. Good corn soils are highly prized and are especially valuable in the southern part of the State, where the long growing season allows the use of large heavy-yielding late varieties of corn. Although corn is grown on almost every soil type within the county, some of the soils are better adapted to it than others, and a few that are now cultivated for corn could be utilized for other purposes to better advantage and with less injury to the fields by erosion. A good corn soil must be well drained, well supplied with available plant nutrients, high in humus or organic matter, comparatively easy to handle, capable of holding plenty of moisture in reserve for the plant's use during the dry parts of the summer, and have such smooth surface relief that run-off water will not remove plant nutrients and organic matter by surface wash. In order to use machinery and labor efficiently, the fields should be regular in shape and of sufficient size to eliminate frequent turning during preparation of the land and caring for the crop.

Although corn is grown in all sections and on practically every soil type, the better cornland occurs mainly on the wide divides between the streams east and south of Cedar Creek, where the surface relief is level or gently rolling. Surface drainage of these lands is good in the gently rolling areas and poor on the level plains, and subsoil drainage of most of the soils is poor because of the underlying impervious clay subsoil. All the soils, however, occurring on the level divides are not good corn soils. In some places, these flat areas are underlain by a gray floury layer and a very tough subsoil, locally termed "hardpan", and the surface soil may range in color from brown to gray or almost white. These gray-layered soils are generally

regarded as poor corn soils and are better adapted to small grains and hay. In the more rolling areas the proportion of cornland is even smaller. Some of the gentler slopes and ridge crests may be cultivated without damage from erosion, but these areas represent only a small proportion of the total area of land of this kind. Hundreds of acres of land that have been farmed in the past have become so badly eroded that they can no longer be utilized as crop land. Abandoned farmsteads are numerous throughout these areas, and the condition of the farms where the fields have been cut by deep gullies, the surface soil removed, and the tough subsoil exposed, readily explains the reasons for farm abandonment.

Topographic features largely determine the extent to which the land may be used for crops, and the surface relief, which ranges in different places from almost level to broken, influences the distribution of the types of farming and the cropping systems. The level land lends itself well to general-farming practices, as the rectangular fields containing a large proportion of tillable land allow the adoption of regular rotations which eliminate the evils of continuous cropping to grain crops and favor the maintenance of soil fertility. In the more rolling areas, where the crests of the hills and the upper slopes are the only parts which can be cultivated, tillable areas are small, and it is necessary to crop the available cultivable land almost continuously. Such areas include a large proportion of hay and pasture land, and farmers depend almost wholly on roughage to carry their livestock through the winter. In the extremely rough sections, only small isolated fields are suitable for cultivation, and these must furnish the feed needed on the farm, therefore, these fields must be used continuously for corn and small grain. Erosion on some of these fields is rapid, many gullies form and cut rapidly into the hillsides, and the dark-colored organic surface layer is being gradually removed by sheet erosion. A large part of this broken land is so densely wooded that the grass undercover cannot survive, and the use of the land for pasture is decreased. Much of the woodland has been cut over and has become even less valuable, as the stumps have been allowed to sprout profusely, and brush and weeds have sprung up so thickly that livestock have difficulty in getting through. The grass has been smothered out, and the only feed available is the leaves of the trees and shrubs.

In grouping the soils of Monroe County on the basis of the purpose for which they are best adapted, it must be remembered that although they may be better suited for one particular crop, other crops are grown also. Corn, the principal crop, because it serves as the basic grain in the rotation, is grown even though the soil may not produce economical yields. Basing the classification of the soils on the use for which they are best adapted, they may be placed into three major classes as follows: (1) General-farming soils, (2) small-grain and hay soils, and (3) pasture soils.

In the following pages, the soils are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

TABLE 5.—*Acreage and proportionate extent of soils mapped in Monroe County, Iowa*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Grundy silt loam	58,368	21.1	Weller silt loam	36,416	13.1
Edina silt loam	2,112	.7	Putnam silt loam	4,672	1.7
Waukesha silt loam	256	.1	Marion silt loam	1,088	.4
Waukesha loam	256	.1	Calhoun silt loam	384	.1
Bremer silt loam	3,008	1.1	Lindley silt loam	40,000	14.4
Bremer silty clay loam	384	.1	Dubuque silt loam	12,672	4.6
Chariton silt loam	768	.3	Wabash silt loam	29,056	10.5
Wabash silt loam, colluvial phase	448	.2	River wash	64	.1
O'Neill fine sandy loam	64	.1			
Clinton silt loam	21,824	7.9	Total	276,480	
Shelby silt loam	64,640	23.4			

GENERAL-FARMING SOILS

The first group, or general-farming soils, includes those soils occurring on the broad divides, the level well-drained terraces, and the smooth tillable slopes, where all crops can be successfully grown. Here the tillable land is more extensive, and it is not necessary to practice continuous grain cropping of any one field in order to obtain sufficient feed for use on the farm. This group includes the dark-colored soils which are, for the most part, well drained and the most fertile soils. The members of the group are Grundy silt loam, Edina silt loam, Waukesha loam, Waukesha silt loam, Bremer silt loam, Bremer silty clay loam, Chariton silt loam, O'Neill fine sandy loam, and Wabash silt loam, colluvial phase.

Grundy silt loam.—Grundy silt loam is the predominant soil of the broad level divides. It is extensively developed on the plain around Albia, on the divides followed by the Chicago, Burlington & Quincy Railroad and State Highway No. 59, which extend northeasterly from Albia, and on the divide traversed by State Highway No. 60 from Albia north to Lovilia. Smaller areas are developed in every township, and this soil comprises the most valuable land in the county.

The surface soil of Grundy silt loam is dark grayish-brown friable silt loam to a depth ranging from 8 to 12 inches. When moist the soil appears very dark brown, in some places black. Beneath the surface layer, the soil material loses some of its dark organic color and becomes heavier in texture. At a depth of about 28 inches the mottled drab, gray, yellow, brown, and black heavy plastic clay subsoil is reached. With increase in depth, the gray color becomes more pronounced and the mottlings of yellow and brown are brighter. This layer is very tough and impervious to water, very hard when dry, and sticky when wet. Below the extremely heavy subsoil, the material is lighter in texture, approaching rather compact silt loam which is decidedly gray and streaked with yellowish-brown and rust-brown stains. The surface soil is very acid in reaction, requiring 3 tons or more of ground limestone an acre to neutralize its acidity. The underlying soil material also shows a decidedly acid reaction, but it is not so acid as the surface soil.

Not all the areas mapped as Grundy silt loam have a profile as described in the preceding paragraph. The thickness of the dark-colored surface layer may range from about 8 inches to more than 17

inches, and the texture, in most places friable silt loam, may become very heavy silt loam in small depressions in the fields. In many places a gray color or the beginning of the development of a gray subsurface layer may be observed. Where this development occurs in areas of sufficient size to warrant separation, the areas are indicated on the soil map as Edina silt loam. Where Grundy silt loam adjoins areas of better drained soils, the subsoil may show a gradation from the typical dark-drab color to a yellowish-brown color.

It is presumed that areas of Grundy silt loam were originally flat and drainage was slow, but drainage conditions of this soil are now variable. Where the surface is gently rolling or where the bodies are not large, natural drainage is fairly well established. The heavy subsoil prevents the free movement of water, regardless of the relief, and is especially detrimental to good drainage where the areas are level and extensive, so that artificial drainage of exceedingly flat fields is necessary in many places before best results are obtained.

This soil is regarded as the best general-farming soil in the county. The dark color is indicative of potential fertility, and crop yields tend to bear out this fact. The cropping system generally followed includes the growing of corn 2 years, followed by oats or some other small grain, and occasionally seeding down to meadow with a mixture of clover and timothy. Many fields are not regularly seeded to grasses but may be cropped to corn and oats alternately for a period ranging from 5 to 8 years and then seeded down. Under the ordinary system of farm management, where legumes are not grown regularly, corn yields average about 35 bushels an acre; but those farmers who have adopted regular rotations and who utilize all the manure produced and occasionally use superphosphate fertilizer on the corn crop, report acre yields as large as 75 bushels.

During the progress of the survey two farms consisting entirely of Grundy silt loam, located on opposite sides of a highway, were observed. Each was under different management. One operator followed a definite cropping system, which he adopted 15 years ago, consisting of a rotation of corn, corn, oats, and red clover. The other farm was cropped to corn and oats alternately for 5 years and then seeded down to timothy and clover. Neither farmer had used commercial fertilizer or applied limestone to his fields. Reports of crop yields on the two farms were obtained from the operators and averaged for a long period. Corn yields averaged 58 bushels an acre on the farm where a planned rotation was practiced and 34 bushels an acre on the other farm. Oat yields were 63 bushels and 46 bushels an acre, respectively. An excellent stand of clover was growing on the well-managed farm, and the hay meadow on the other consisted of a thin stand of timothy, a few clover plants, and an abundance of daisies and other weeds.

Grundy silt loam responds well to proper treatment. A large proportion of this land has been under cultivation from 50 to 75 years, and during this period but little attention has been directed toward maintaining the soil fertility. The organic-matter content has become depleted to such an extent that the physical condition of the soil has been changed. Lack of humus makes the soil puddle if worked when wet, and the lumps of soil bake hard on drying. The moisture-holding capacity is so lowered that plants suffer during periods of drought. This fact was well demonstrated during the dry years of 1930 and 1931,

when fields near buildings which received the largest quantity of manure produced better crops and the plants showed much less drought injury than outlying fields low in organic matter.

For best results with legume crops, it is advisable to correct the soil acidity by applications of ground limestone. This is absolutely a prerequisite to the growing of alfalfa and sweetclover. It is a common complaint among farmers in this section of the State, however, that it is becoming more difficult to obtain satisfactory stands of red clover. This may be explained by the relatively low state of fertility, especially in regard to phosphates, and the excessive acidity of the soil. Under a good rotation system Grundy silt loam can be made to produce high yields continuously. With the limited acreage of good cornland and tillable land to be used for any crop, this soil will be expected to produce to its maximum capacity.

Edina silt loam.—Edina silt loam is closely associated with Grundy silt loam. It occurs on the level divides in isolated spots, most of which are slightly depressed or extremely flat, within the large areas of Grundy soils. The bodies range in size from less than 1 acre to more than one-half square mile. This soil is generally regarded as inferior to Grundy silt loam in its ability to produce crops.

The surface soil is very dark grayish-brown silt loam when dry and is almost black when wet. It ranges in thickness from 5 inches to more than 12 inches. Beneath the surface layer is a layer of fine floury rather compact silt loam, ranging from gray to almost white in color, and from 3 to 10 inches in thickness. This gray layer is the distinguishing characteristic of the Edina soils, and in many places it is close enough to the surface to be brought up when the fields are deeply plowed. It has a tendency to retard the movement of moisture, and the land is poorly drained. Beneath the gray silty layer is very tough plastic silty clay or clay, which bakes hard on drying. The colors of this material are varied, being mainly drab and gray stained with yellow, brown, and black. At a depth of 50 or more inches, the material becomes lighter in texture, and the gray color predominates. The entire soil profile is decidedly acid in reaction, the surface soil and gray layer showing the greatest acidity.

Edina silt loam occurs in numerous small areas, mainly in the southern half of the county, but the total acreage is markedly less than that of Grundy silt loam. It is exceptional for a farm to consist entirely of Edina silt loam. When farmed in conjunction with Grundy silt loam, no special attention is given to the Edina soil, although farmers recognize this soil because crop yields are lower than on soils not having the gray subsurface layer. When other parts of the field produce an acre yield of 50 bushels of corn, Edina areas invariably produce from 8 to 12 bushels less. The effect of the gray layer is not so noticeable with oats and clover as with corn, but even these crops do better on the adjoining soils.

Because Edina silt loam occurs in exceedingly flat or slightly depressed areas, drainage is naturally poor, as the gray compact silty layer and the tough impervious clay subsoil hinder the movement of water. Tiling does not alleviate conditions unless the lines are laid very close together, because the drawing power of the tile is weak in the heavy subsoil. Where the tiles are laid above the heavy clay subsoil the danger from frost injury is increased, and if the tiles are laid in the clay layer below the frost line, broken stones, broken tile,

gravel, and the black surface soil should be placed on top of the tile, and the heavier soil above, to prevent clogging of the lines by the fine clay particles.

As it is very acid in reaction, Edina silt loam would be greatly benefited by heavy applications of lime. A well-limed soil will produce sweetclover and alfalfa, which are deep-rooted plants that send their long roots well into the tough subsoil. When the plants die, the roots decay, leaving a channel for moisture to reach lower levels and for air to enter, thereby allowing better aeration and oxidation in the subsoil.

Waukesha silt loam.—Waukesha silt loam is not extensively developed but is one of the better corn soils. It occurs on high well-drained terraces along Cedar Creek. The topmost 12- or 14-inch layer is grayish-brown friable silt loam containing some very fine sand. The upper part of the subsoil is lighter in color, being more brown, and the texture ranges from heavy silt loam to light silty clay loam. The subsoil, below a depth of 24 inches, is light-brown or yellowish-brown silty clay loam which is compact in place but not impervious. A few faint gray streaks are noticeable below a depth of 38 inches.

Nearly all of this soil has been placed under cultivation. Corn is the chief crop, and the land is kept in this crop almost continuously. Occurring as it does in conjunction with untillable hilly land on the one side and overflow land on the other, the soil must be kept in crops constantly to supply feed for the farm animals. The presence of a small percentage of sand in the surface soil makes it easy to handle and allows working under rather adverse moisture conditions, without apparent injury to its physical condition.

This soil responds well to manurial treatment, and, as it is one of the few cultivable soils in the localities where it has been mapped, a large part of the manure produced on the farms is applied to these high terraces. Under this treatment the soil has been able to withstand heavy grain cropping, and yields have remained uniform over a period of years. Corn yields range from 35 to 60 bushels an acre, and oats from 40 to 65 bushels, depending on seasonal conditions. Hay crops are very seldom grown, and during the progress of the survey not a single field of this soil was observed in clover or meadow of any kind.

Waukesha loam.—Waukesha loam is very similar to Waukesha silt loam, except that the surface layer contains sufficient sand to give it a loamy texture. The lower soil layers are approximately the same as the corresponding layers of the silt loam, except they contain a higher percentage of fine sand throughout the profile.

Waukesha loam is developed along the courses of Cedar Creek and Grays Creek, and the total area is the same as that of Waukesha silt loam. Because of the presence of sand, Waukesha loam is very friable, easy to handle, and may be worked within a few hours after rains without danger of clodding. This soil is not so fertile as Waukesha silt loam, as evidenced by the slightly lower crop yields obtained.

Both soils are very acid in reaction, in both the surface soil and lower layers. Heavy applications of limestone and barnyard manure and the plowing under of green-manure crops, preferably legumes, would aid materially in increasing crop yields. Even though cultivable land is limited in places where these two soils occur, it is advisable to place them under a regular cropping system, as the increase in corn and small-grain yields following a legume crop would almost equal the yields obtained when continuously cropped to corn and oats.

Bremer silt loam.—Bremer silt loam has a very dark grayish-brown or nearly black silt loam surface layer which when wet appears black and becomes somewhat sticky. Below a depth of 12 inches, the dark color begins to disappear and the material shows more gray, with streaks of rust brown and black throughout. At a depth of about 20 inches the basic color is gray, mottled or stained with yellowish brown, rust brown, and black, indicating poor subsoil drainage. The texture of the material in the lower layers ranges from silty clay loam to almost clay, and it is heavy, compact, and very impervious. The entire soil mass shows an absence of lime carbonates, and analyses indicate strong acidity. The maximum acidity is in the surface layer.

This soil occurs on low terraces along all the larger creeks. The areas are level and lie but a few feet above the present flood plain of the streams. Natural drainage is fair or poor. The smaller bodies are fairly well drained, but the large areas require artificial drainage for maximum crop yields.

Bremer silt loam is primarily a corn soil and is cropped to corn almost continuously. Yields are high and compare favorably with those on the best upland soils. The high natural fertility of the soil enables it to withstand heavy cropping better than any other soil. Small grains produce a rank growth of stalk and lodge badly because of the high fertility of the land. Corn yields in normal years average approximately 45 bushels an acre. In wet seasons the yield is reduced somewhat because of poor drainage, and in dry seasons yields rise above the normal level.

Bremer silty clay loam.—Bremer silty clay loam is closely associated with Bremer silt loam, differing from that soil mainly in that it has an extremely heavy sticky silty clay loam surface layer and occurs on flat poorly drained terraces below the level of Bremer silt loam. The surface layer is very dark brown or black silty clay loam 18 or 20 inches thick. It is sticky when wet and bakes hard on drying. Large cracks form on the surface and extend into the subsoil during dry seasons. The subsoil is gray clay heavily stained by iron and showing poor drainage. This soil is very acid from the surface downward.

About one-half the land is under cultivation, and the other half supports a rank growth of sloughgrass. Corn is the only crop grown, as small grains grow so rankly that they lodge badly. In normal or dry years corn on this heavier soil outyields that on Bremer silt loam, but in wet years the yields are very low. The average yield over a series of years shows Bremer silty clay loam inferior to Bremer silt loam in productivity.

Chariton silt loam.—Chariton silt loam is a terrace soil lying well above overflow and occurring in small areas along the principal streams. The 10-inch surface soil is dark grayish-brown silt loam, appearing very dark brown or black when wet. Beneath this dark surface layer is very fine or floury gray or almost white silt loam which is compact in place but when broken out falls into an ashy mass. Many small rust-brown and black iron pellets give the material a gritty feel and a streaked appearance when rubbed between the fingers. Below the distinguishing gray layer is gray and brown very tough impervious clay, mottled with yellowish brown and streaked with black and rust brown. Gray and dark-drab colors increase in intensity with depth. Natural drainage is fair on the surface, but

the heavy impervious subsoil greatly retards the downward movement of water. The entire soil mass is leached of its lime carbonates. The greatest acidity is in the surface layer and gray subsurface layer.

Practically all of this land is under cultivation and utilized mainly for corn and small grains. The fields are seeded to clover and timothy meadow after several crops of corn and oats have been grown. This soil is not so fertile as the previously described soils of this group, but, because it occurs in localities where tillable land is at a premium, it is farmed and cropped almost continuously.

Wabash silt loam, colluvial phase.—Wabash silt loam, colluvial phase, has a very dark brown or black deep silt loam surface layer. This soil occurs at the bases of slopes and along a few of the small upland draws. The material has been washed from the slopes during heavy rains and deposited where the excess water spread over wide areas.

The thickness of the surface soil ranges from 12 inches to more than 24 inches. Below the silty surface layer the change in color is slight, but a noticeable change occurs in the texture—from silt loam to silty clay loam. At a depth of 4 feet the dark organic color begins to fade and is replaced by the slate-gray color of the deep clay subsoil.

The largest area mapped occurs along Avery Creek in Mantua Township and covers about 80 acres. The surface relief is in general flat, and the slight relief noticeable is a slope toward the stream bed.

Although inclined to be exceedingly wet during the spring and fall, this is one of the best corn soils in the county. It is almost continuously cropped to corn, and it withstands this method of farming without apparent injury for a number of years. Oats, winter wheat, and barley are used to supplement corn when it becomes necessary to substitute other crops, and occasionally the fields are seeded to a mixture of timothy and clover. The clover is utilized for hay the first year, and, as the legume thins out the second year, the timothy then makes its maximum growth. The timothy is either cut for hay, or, if market prices are satisfactory, the crop is cut and the seed threshed and sold to local elevators as a cash crop.

The small total area of this soil results in its being unimportant agriculturally, even though it is one of the most fertile soils.

O'Neill fine sandy loam.—O'Neill fine sandy loam occurs on high terraces. The areas are well above overflow and, because of the porousness of both surface soil and subsoil, the land is inclined to be droughty. The areas are level or hummocky, the slight rises being more sandy than the surrounding soil.

The surface soil, to a depth of about 8 inches, is dark-brown fine sandy loam which passes gradually into lighter brown fine sandy loam containing more silt than the surface layer and being more compact in place. At a depth of 24 inches, the dark organic color disappears and the material consists of light-brown fine sand or loamy fine sand. The lower layers are very porous and incapable of retaining moisture.

This soil occurs in a small area along Cedar Creek in Union Township. The entire acreage is under cultivation and is used for the production of corn and oats. Small grains are better adapted to this sandy soil because they mature early enough in the season to escape the annual dry season. During the year of the survey (1930) this land was in corn, and the crop was severely damaged by drought, resulting in an almost complete crop failure.

SMALL-GRAIN AND HAY SOILS

The second group of soils includes those soils best adapted to the production of small grains and hay. This does not mean, however, that corn cannot be and is not grown on them, but that they cannot be frequently cropped to corn successfully, either because of their low fertility or because of injury to the fields from erosion when planted too often in cultivated crops.

The surface features of the areas of these soils are varied, ranging from those of the nearly level upland to those of dissected valley slopes. Each topographic type originally supported a different vegetal cover which has influenced soil development. The deeply cut stream valleys were originally forested, the moderately rolling land supported a growth of brush or scattered trees, and the smooth upland was carpeted with grasses.

Three members of this group, Clinton silt loam, Shelby silt loam, and Weller silt loam, have come to their present condition through too frequent cropping. All three occur in the hilly sections where erosion is difficult to control. Continuous corn and oat cropping has caused the removal of practically the entire surface layer and has been one of the principal factors in the formation of deep gullies extending to the crowns of many of the hills. It is in these areas that abandoned farms are the most numerous.

Among the better farmers operating on this kind of land, the general practice is to seed the fields to small grain which serves as a nurse crop for the grass seeding which consists of a mixture of timothy and clover. Hay is cut for 1 or 2 years, and the fields are then pastured until the stand thins and weeds crowd out the pasture grasses. When this condition is reached, usually 3 or 4 years after seeding, the land is again plowed, one crop of corn is grown, if the slope is not too steep, and the field is again seeded to oats and grass. Under this system, erosion is controlled as well as possible, and the land is utilized to the best advantage. The soils included in this group are Clinton silt loam, Shelby silt loam, Weller silt loam, Putnam silt loam, Marion silt loam, and Calhoun silt loam.

Clinton silt loam.—Clinton silt loam has an 8-inch surface soil consisting of brownish-gray friable smooth silt loam. When wet the soil appears light brown, but it dries to a gray and in some places to an almost white color. The depth of the surface layer differs with the relief and the extent to which the fields have been cultivated. In the uncultivated areas it exceeds 10 inches in many places, but in cultivated fields it is decidedly thinner and the subsoil is exposed in places where steep slopes have been heavily cropped. Beneath the surface layer the material gradually changes from pale yellowish-brown heavy silt loam to dark yellowish-brown silty clay loam, and below a depth of 20 inches the soil mass is yellowish-brown and gray compact plastic heavy clay. The gray color increases in intensity with depth, and, at a depth of about 45 inches, the color is gray and brown, with gray predominant, but both well developed. Below a depth of 50 inches the material becomes lighter in texture but shows little or no change in color from the overlying horizon. The entire soil profile to a depth of 7 feet or deeper has been thoroughly leached of its lime carbonate, especially the surface layer, which shows a strong acid reaction.

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The land, in its natural state, is heavily timbered with white oak, hickory, red oak, and some elms. The light color of the surface layer indicates a low content of organic matter.

This soil occurs in every township in the county. It is developed on the heavily wooded slopes near streams, where the surface relief is hilly and drainage is good or excessive. Approximately 60 percent of the total area has been cleared and is now or was formerly used for the production of crops, but about one-fifth of the cleared land has become so badly eroded and gullied that it can no longer be farmed. Some farmers have allowed such land to grow up to grass, but brush and trees are rapidly encroaching over the slopes and diminishing the value of the land for pasture. The wooded areas furnish fuel for the farms, props for mines, and rough lumber for repair work around the farm. Cut-over land soon becomes valueless unless the sprouts are controlled, as the brushy growth becomes so dense that the grass dies out and livestock find little grazing other than leaves.

The cleared and cultivated areas are generally farmed in much the same manner as the better soils of the county. Corn, oats, rye, barley, and timothy and clover hay are the main crops. It is generally recognized that Clinton silt loam is not a first-class corn soil, but because all farm practices are centered around corn it is considered necessary to grow corn, even on soils much better adapted to other crops. Corn yields are low, except where heavy applications of manure or crops of clover have been plowed under prior to planting the corn; but even if corn yields were high the loss of plant foods and washing away of the surface material when the soil is in a cultivated state would more than offset any yield that could be obtained.

As it is subject to washing, this soil should be kept covered as much as possible, and the growing of small grains and hay greatly minimizes the annual loss through erosion. If the fields must be plowed occasionally for reseeding, they should never be planted to corn more than 1 year and then seeded down to grass. The best estimates obtained from farmers on average corn yields in all parts of the county place the yield at about 30 bushels an acre. The lowest yield was given as 18 bushels and the highest as 45 bushels.

Small grains produce well, as the crop is on the land, has made a good growth, and has established a good root system before the heavy June rains, thereby preventing sheet erosion which always takes place when the field is in a cultivated crop. Small grains mature before the annual drought period in late July and August. The hay crop seeded with the small grain is well established by fall and is capable of holding the soil in place for 2 or 3 years following the small grain. Yields of all small grains are high, compared with yields of corn. In many years, oats yield 65 bushels an acre, and yields of other small grains are comparable. Badly run-down farms, where practically all the surface soil has been removed and the yellowish-brown subsoil is exposed, do not yield so well as the better managed farms. However, they can more easily be improved when the cropping system includes mainly a small grain and a legume than when corn is grown 2 or 3 years in succession. It is necessary to grow a cultivated crop after a period of 5 or 6 years, in order to control weeds which gain a foothold in old meadows.

The hay meadows consist of a mixture of red clover and timothy. The clover is cut for hay the year following seeding, and the timothy

is either cut for hay or seed, according to the needs of the farm. Good clean stands of timothy are regarded as more valuable for seed than for hay. Excellent stands of red clover were observed on many fields of Clinton silt loam, and because this legume grows well, is superior to timothy for hay and pasture, and supplies an abundant source of organic matter it should be grown exclusive of timothy on more farms.

Shelby silt loam.—Shelby silt loam is an upland soil developed in the hilly nontimbered sections near the streams and their tributaries. The surface relief ranges from hilly to broken, and drainage from good to excessive. The material from which this soil has been developed was derived from two main sources—the silty surface layer from loess and the subsoil from glacial till.

Shelby silt loam has a dark grayish-brown friable silt loam surface layer containing various percentages of fine sand. The thickness of the surface layer differs with the surface relief, being greater on the crests of the hills and at the bases of the slopes, but on steep slopes the entire covering of silty material has been removed. The upper subsoil layer is dark yellowish-brown gritty silty clay loam. Boulders of different sizes are embedded throughout the subsoil. The color of the deeper part of the subsoil, at a depth below 20 inches, is not uniform. In one place it may be almost reddish brown, in others it may be yellowish brown, and in still others it may be gray or slate gray. The texture of the lower layers is universally heavy or gritty clay loam. The number of small boulders decreases with depth. Lime carbonate has been thoroughly leached from the upper layers, but, in many places, it occurs in streaks through the lower layers, below a depth of 4 feet.

About 70 percent of the total area of Shelby silt loam has been at one time under cultivation, but at present less than 50 percent is fit for crop production. The gentler slopes are farmed in the usual manner and cropped to corn, oats, barley, and hay. Corn, the principal crop, is grown as often as possible, and oats and hay are grown only after the fields wash so badly that further cropping to corn would result in serious injury. Methods of handling this soil compare with those described for Clinton silt loam. Small grains and hay are better adapted to the soil than is corn.

One of the problems in farming Shelby silt loam fields is the correction of seepage spots which occur on the slopes. In some localities these spots are called "push soils" or "spouty spots." They are unsightly, hard to handle, and unproductive. Artificial drainage with tile lines laid above the seepage area aid materially in correcting them.

Weller silt loam.—Weller silt loam has a grayish-brown smooth silt loam surface soil which varies in thickness. Some slopes and ridge tops are completely devoid of the silty layer, and in few places does it exceed a thickness of 6 inches. The silty layer rests on yellowish-brown and gray silty clay loam which gradually becomes heavier with depth and shows some staining by iron oxides. Below a depth of about 15 inches is dark-drab, mottled with brown and yellow, very tough clay which dries hard as stone when exposed on the surface. At a depth of 20 inches, the heavy clay changes in color to mottled gray and yellowish brown, and it becomes heavily stained with iron. Below a depth of 36 inches, the gray color predominates, the iron

staining is less pronounced, and the texture changes from heavy clay to friable though compact silt loam.

This soil occurs in the hilly sections near streams, occupying a position on the narrow ridges and steep slopes. Trees have not gained a foothold, but much of the land was originally covered by hazel-brush, buckbrush, and berry bushes.

Less than one-fourth of the total area is under the plow at present. The steepness of the slopes, and the character of the subsoil, which is practically everywhere within plow depth, render this soil undesirable as crop land. The area under cultivation is utilized mainly as hay land, and the rest serves as permanent pasture. Little can be done to improve the soil because of the surface relief. Many areas have become so badly eroded that the tough clay subsoil has been exposed, and even weeds cannot thrive on it. The better areas produce good yields of small grains. When possible to obtain stands of clover or timothy these fields are considered valuable as hay and pasture land.

Table 6 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and several layers of the subsoil of Weller silt loam. Under the method of analysis now used in the Bureau of Chemistry and Soils, this soil analyzes silty clay, but it showed the characteristics of a silt loam in the field.

TABLE 6.—*Mechanical analyses of Weller silt loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Per cent*
338253	Surface soil, 0 to 1½ inches	0.2	1.2	2.1	3.3	2.2	51.4	39.5
338254	Subsurface soil, 1½ to 5 inches	.2	.5	.9	1.5	1.1	57.0	38.7
338255	Subsoil, 5 to 10 inches	.1	.2	.4	.6	.8	56.3	41.5
338256	Subsoil, 10 to 15 inches	.1	.2	.4	.5	.7	51.3	46.8
338257	Subsoil, 15 to 21 inches	.1	.1	.1	.3	.5	45.3	53.6
338258	Subsoil, 21 to 41 inches	.0	.1	.2	.4	.7	54.8	43.7
338259	Subsoil, 41 inches+	.1	.0	.1	.1	.9	62.9	36.0

Putnam silt loam.—The surface soil of Putnam silt loam is grayish-brown smooth friable silt loam to a depth of about 9 inches. The silt particles are very small and impart a floury feel, but a few hard rust-brown and black iron pellets in the lower part of this layer give the mass a gritty feel. Beneath this surface material is a layer of floury or ashy silt loam, ranging from gray to white in color. It is firm in position but readily falls apart when disturbed. Numerous iron pellets and soft iron accumulations give a mottled or streaked appearance to this layer. This distinctive gray layer passes abruptly into heavy clay, the basic color of which is brown, with mottlings of drab, dark gray, yellowish brown, and black. The subsoil layer is one of the heaviest underlying any soil in the county, being compact, impervious, and plastic. When dry the material is very hard, and it breaks out into blocks with wide cracks between them. During the drought period of 1930 and 1931, cracks almost 1 inch wide were found in the subsoil at a depth of 5 feet. With depth, the color changes to dark gray and the texture becomes lighter, and at a depth of about 60 inches the material is gray, mottled with brown and yellowish brown, silt loam.

Putnam silt loam differs from Edina silt loam in having a lighter colored surface soil, a more distinct development of the gray subsurface layer, and a much heavier subsoil. It occurs on narrow flat ridges, mainly in areas surrounded by woodland, but this soil has never been timbered. Natural drainage is poor because of the flat relief and the imperviousness of the lower layers. The fields dry out slowly in the spring, and harvesting of the corn crop is hindered in the fall during wet seasons. This land is difficult to drain artificially, and most of it is farmed in its natural state. The entire soil profile is extremely acid in reaction, the greatest acidity occurring in the surface layer and the gray layers.

Practically all the land is farmed to corn, oats, barley, and hay. Corn yields differ with seasonal conditions, being very low in wet years and higher in dry seasons, ranging from 20 to 35 bushels an acre. Oats, barley, and hay yield better than corn. In recent years soybeans have been grown successfully on this soil. Because of the high acidity and poor drainage, it is difficult to obtain stands of clover, and winter-killing and drowning out during the spring and fall cause a lowering in the yields of clover hay.

Marion silt loam.—Marion silt loam is locally called "white land", or "white oak land." It has a light-gray or nearly white surface soil, the particles of which are very fine and have a floury feel. Numerous brown or black iron pellets occur throughout the surface material, and the surfaces of many cultivated fields are covered with these small shotlike iron concretions. Beneath the 7-inch surface layer is a lighter colored, almost white, layer which is more ashy or floury than the surface material. This layer is similar to the light-colored layers under the Edina and Putnam soils. The subsoil beneath the ashy silt loam is dark-drab heavy impervious clay which becomes lighter textured with depth and more gray in color, but the entire subsoil is very heavy and impervious.

Marion silt loam occupies the narrow flat ridges in the wooded sections of the county. The areas are not extensive but are numerous. Natural drainage is poor because of the level relief and heavy subsoil. This soil differs from Edina silt loam and Putnam silt loam in having an extremely light colored surface layer.

As this soil occurs in places where tillable land is at a premium, it is cropped heavily. Although it is one of the poorest corn soils in the county, it is planted to this crop at frequent intervals. Yields of corn as low as 15 bushels an acre are not uncommon, even in normal years. Small grains and hay are better adapted to the soil, and they yield well. Acre yields of 65 bushels of oats have been made, and only in exceptionally wet years are the yields extremely low. If a stand of clover can be obtained on these very acid soils, the yield is from 1½ to 2½ tons of hay an acre.

The light color, which indicates a low supply of humus, and poor drainage are factors which greatly limit crop yields on this soil, and correction of these two conditions greatly improve its crop-producing power.

Calhoun silt loam.—Calhoun silt loam is very similar to Marion silt loam in the color of the surface soil, the gray layer, and subsoil characteristics. The principal difference between the two soils is in the positions where they occur. Calhoun silt loam is developed on ter-

races and is mapped on high benches along streams, and Marion silt loam is a soil occurring on flat upland areas.

Calhoun silt loam has a light grayish-brown fine smooth silt loam surface soil underlain by the characteristic gray layer and drab clay subsoil.

Most of the terraces are narrow and extend along the streams for considerable distances. Natural drainage is poor on these flat benches. They are cropped much the same as all other tillable soils of the county. Although corn yields poorly, it is grown on a large proportion of the land annually, but like on Marion silt loam, better yields of small grains are produced. Good stands of red clover were observed on many Calhoun silt loam terraces, which indicate that these fields are more valuable as hay land than as grain land.

PASTURE SOILS

The third group of soils includes those soils that cannot be cultivated and are used almost exclusively for pasture, although they do not include the entire pasture area of the county, as a large proportion of some of the soils described in the small-grain and hay group is utilized as permanent pasture. For instance, Weller silt loam, Shelby silt loam, and Clinton silt loam occur in the hilly sections of the county, where the steepness of the slopes and their eroded and gullied condition make cultivation impossible on a considerable acreage of these three soils. The soils used almost exclusively for pasture are Lindley silt loam, Dubuque silt loam, Wabash silt loam, and river wash. The first two are extremely rough and heavily timbered, and the last two are bottom-land soils subject to frequent overflow.

Lindley silt loam.—Lindley silt loam is a timbered soil occurring in the breaks near the streams. The surface relief ranges from hilly to broken, the slopes are steep, the ridges narrow, and the land for the most part uncultivable.

The surface soil is brownish-gray silt loam containing some fine sand. The thickness differs with the slope, being greater on the ridge tops and lower slopes and very thin or entirely absent on the upper slopes. The upper part of the subsoil is yellowish-brown plastic gritty clay, and the lower part is gray, brown, and yellowish-brown silty clay loam containing some fine sand and boulders of different sizes. The subsoil may range in color from gray to reddish brown, depending on the degree of oxidation.

A small part of the land has been cleared, and attempts have been made to crop it, but the steepness of the slopes favors rapid removal of the silty layer and exposure of the clay subsoil. Such fields do not remain under the plow long and are allowed to revert to brush and grass when they become no longer suitable for cultivation. Much of the land has been cut over, and the trees have been used mainly for fuel and mine props. A few of the better trees are used for rough lumber and timbers for barns and sheds around the farmsteads. The stumps on the cut-over land have been allowed to sprout, and the second growth has become so dense that the land is practically valueless except as sheep or goat pasture. In the virgin timber areas, bluegrass has gained a foothold where the stand of trees allows some sunlight to reach the ground, but the heavily timbered areas support

an undercover of weeds and small brush capable of surviving without much sunlight.

Dubuque silt loam.—Dubuque silt loam occurs mainly in the northern half of the county. It occupies an upland position on the precipitous slopes adjacent to the streams and their tributaries. The surface soil is merely a thin covering of silty material, ranging in color from brownish gray to dark brown, which rests on the solid country rock and shale. The rock and shale outcrop at the bases of the slopes.

The soil cannot be cultivated to advantage. The rockiness of the steep slopes prevents its utilization for any purpose other than pasture. Most of it is covered by a growth of oaks, hickory, elm, and basswood, and a few walnuts grow in the narrow valleys. The undergrowth is bluegrass, buckbrush, and berry bushes, which supply feed for cattle. The steep slopes are not accessible to livestock and are regarded as waste land.

Wabash silt loam.—Wabash silt loam is a first-bottom soil having a deep dark-brown or almost black surface layer. The texture is principally silt loam, but various proportions of sand occur within short distances, the wider bottoms being universally silty in texture and the narrow bottoms containing more or less sand. The strip adjacent to the stream channel is everywhere more sandy than the bottom a short distance from the stream. The subsoil is gray, stained with brown and rust brown, silty clay loam. No lime carbonate is present in any part of the soil profile.

The first bottoms of the streams of Monroe County are narrow, the flood plain of Cedar Creek being the most extensive. It is difficult to crop these bottoms because of the hilly relief of the county as a whole. Rapid run-off from the uplands occurs during rains, this surplus water is conducted to the master streams by the well-established drainage system, and the rapid accumulation of water into the main channels causes frequent flooding. The large areas along Cedar Creek are farmed to some extent, but the uncertainty of the maturing of a crop is such that this practice is discouraged. Corn is the only crop grown, and it yields heavily when flood waters do not injure it. In its natural state, this land supports a luxuriant growth of bluegrass, and a few scattered trees, buckbrush, and weeds form an additional cover. Livestock find good grazing on these bottoms throughout the entire season.

River wash.—River wash consists of sandy and gravelly material deposited along the banks of Des Moines River. The total acreage is small and varies with each flood stage of the river. It is valueless for any agricultural purpose but serves as a source for building sand and gravel and for road-surfacing material.

AGRICULTURAL METHODS AND MANAGEMENT

The total acreage [2] in crops in Monroe County in 1930 was estimated at 100,172 acres, of which 41.6 percent was in corn, 19 percent in oats, 3.7 percent in wheat, 34 percent in all hay crops, and the remainder in minor crops, such as rye, barley, potatoes, and truck crops. Corn, therefore, ranks first in importance. It is grown wherever and whenever possible, and all farming practices depend on the extent to which it can be grown. Every soil type in the county has at some time been

[2] Data from 1930 Iowa Yearbook.

used to produce corn. Areas unsuitable for cultivation have been cleared and cropped to corn and small grains until they became so depleted in fertility and so badly eroded it was unprofitable to cultivate them longer.

The total corn crop in 1930 amounted to 1,096,042 bushels, grown on 47,654 acres, with an average acre yield of 23 bushels. The severe drought during this season greatly lowered the average yield which, in normal years, is well above this figure. In 1925, corn yielded an average of 37.8 bushels an acre, or just 6 bushels less than the State average for that year.

In preparing land for corn, the same general practices are used on all the soil types. The fields are either spring or fall plowed, depending on the surface relief; level fields are universally fall plowed, and the hilly land is spring plowed to avoid erosion. After plowing, the fields are double disked and harrowed, and corn is planted early in May, depending on seasonal conditions. The checkrow method of planting, which facilitates cultivating to control weeds, is practiced. Cultivation begins almost immediately, the first cultivation being done by means of the harrow. Rotary hoes and corn cultivators are used after the corn comes up. The number of cultivations is governed by the weed growth and number of rains. The crop is "laid by" about the middle of July, and harvesting begins in October or November, as soon as the grain is sufficiently dry to crib. Husking is done mainly by hand. The grain is stored in cribs and fed as needed throughout the year to hogs, cattle, and sheep.

In 1930, 81 percent of the corn crop was husked for grain, 2 percent cut for silage, 14 percent cut for fodder, and 3 percent hogged down.

The yellow varieties of corn, which include Reid Yellow Dent, Krug, Leaming, and Iodent, are preferred. Several strains of these varieties, which are better suited to particular soil conditions, have been developed by individual farmers. Hybrid corn obtained from commercial sources has been introduced by a few farmers.

Hay ranks second in total acreage. In 1930, 33,991 tons of hay (including all crops cut for hay) were produced on 34,121 acres. The yield during the last two seasons (1930 and 1931) has been greatly reduced because of drought. Normally, the hay yield exceeds 1½ tons an acre. Hay meadows consist mainly of a mixture of timothy and clover seeded with the small grain which serves as a protection to the young plants until the root system is well established. Red clover makes its maximum growth the year following seeding and timothy the second year. The clover is cut for hay, and the timothy may be cut either for hay or for seed. The production of alfalfa and sweetclover is successful only when the fields are heavily limed, as the strong acidity of all the soils prevents the growth of these legumes unless the acidity is corrected. During the last 5-year period the alfalfa acreage has more than doubled. Demonstration plots, proving that alfalfa and sweetclover can be grown successfully, have created an interest in this excellent hay and pasture legume.

Of the small grains, oats are the most commonly grown, and they follow corn in the rotation or cropping system. The land is prepared by disking the corn-stubble land to cut up the stalks and loosen the topsoil, and, after dragging, the fields are either broadcast or drill seeded. The grain matures in July, is cut by binders, and is shocked

in the field until cured sufficiently to thresh. It is used as feed for work animals or ground and fed to cattle and hogs. In 1930, 21,808 acres were devoted to oats, and the total yield was 667,665 bushels, or an average of 31.1 bushels an acre. Late varieties are grown by most farmers, Richland, Albion, Iowar, and Green Russian are the favorite varieties.

Although wheat has been an important crop in the past, the acreage has been reduced in the last decade. In 1930, 4,063 acres produced 65,837 bushels of wheat, an average of 16 bushels an acre. Winter wheat varieties produce higher yields and are better adapted to this section of the State than spring wheats. The crop follows corn and is handled in the same manner as oats. The grain is sold for cash at local elevators or is used as poultry feed on the farm.

Barley is becoming more popular among farmers each year, as it furnishes feed during the period of the year when corn from the previous crop has been exhausted and the new crop is not available. Some farmers sow oats and barley mixed for feeding purposes, but others grow each crop separately and, if desired, mix the grains in the feeders.

Rye, flax, millet, soybeans, and sorghum cane are minor crops. Soybeans, however, are increasing in importance as a cash crop. With the establishment of a soybean-meal factory at Centerville in the adjoining county, the interest in growing soybeans as a cash crop will undoubtedly increase. Soybeans grow well on highly acid soils. They are better adapted to fields having very little slope, because they have the tendency to loosen the upper 2 or 3 inches of soil material, and, when the crop is removed, the more sloping barren fields are subjected to serious washing and sheet erosion during fall rains.

The pasture acreage of Monroe County is high. The Iowa Yearbook for 1930 reports the total area in farms at 258,569 acres, 58 percent of which consists of land not in crops, or includes pasture, wild-hay land, timberland, waste land, idle crop land, feed lots, and highways. Of the total area, 51.88 percent is in pasture.

Native pastures consist mainly of bluegrass. Some areas are timbered, whereas others have never been wooded, and these, although badly eroded, are the most valuable for grazing. No special attention is given pastures to improve the quality and quantity of feed. Livestock are turned on pasture early in the spring, and good grazing is afforded then and during the fall months when moisture is plentiful, but during the dry months pastures burn out and livestock depend mainly on brush and tree leaves for their existence. Some tame-grass meadows are pastured after two seasons' hay crops have been cut, and this pasture, together with small-grain stubble land and cornfields, carry the livestock well into the winter without feeding.

Monroe County lies wholly within the southern Iowa loess area, where surface relief plays an important part in determining the amount of tillable land and the type of agriculture followed. The most extensively developed soils are the least valuable for crop production. This condition, however, increases the value of the available crop land on each farm and places the burden of producing enough feed for the livestock on a small acreage, and also places the farmer in the unfortunate position of being compelled to continuously crop much of his

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land. This practice has so depleted the fertility of the land that in many places good crop yields are no longer obtained, and some improvement in the method of handling the soil will ultimately be necessary.

The Iowa Agricultural Experiment Station, through the soils subsection, maintains 95 soil-experiment fields located in all parts of the State. These field plots are in counties where the soil survey has been completed, and the principal soil types have been determined. They are supervised by field men from the experiment station, who apply the fertilizers and harvest the crops. The cooperator gives the plots the same care as is given to the rest of the field. Crop yields are recorded and issued in special bulletins or soil survey reports for the different areas.

There are no field experiment plots located in Monroe County under the supervision of the experiment station, but plots on similar soil types in other counties indicate what may be expected from various soil treatments.

Experimental fields are permanently laid out in $\frac{1}{10}$-acre plots on a soil type which fails to produce as high crop yields as may be expected. The experiments are planned to include tests of different kinds of fertilizer treatments under the livestock and the grain-farming systems. The older fields have all been laid out with both systems in each series, but new fields include only manure as the source of organic matter. Under the livestock system, manure is applied at the rate of 8 tons an acre once in a 4-year rotation. The organic matter is supplied to the soil under the grain system of farming by plowing under the crop residues and all the clover crop, if possible, and always the second crop when the first is removed for hay. Ground limestone is applied in quantities sufficient to neutralize the soil acidity, as determined by several tests made in different parts of the field. Prior to 1925, rock phosphate was applied at the rate of 2,000 pounds an acre once in a 4-year rotation, but since that time, 1,000 pounds an acre have been used. Applications of superphosphate, at the rate of 150 pounds an acre, on the two corn crops and small grain are made during the rotation. Clover receives no phosphate fertilizers. Therefore, during a 4-year rotation, 450 pounds of superphosphate an acre are used at the rate of 150 pounds annually for 3 years. A 2–12–2 [3] mixture of complete commercial fertilizer, at the rate of 200 pounds an acre on each grain crop, was used until 1929, when a 2–12–6 mixture at the same rate was substituted. Muriate of potash treatments are made annually at the rate of 25 pounds an acre.

The experiment fields first established consist of 13 plots to each series with 3 check plots. New fields consist of 9 plots and have 2 check plots.

Thirteen experiment fields are located on Grundy silt loam. These are located in Henry, Wapello, Lee, Louisa, Ringgold, Jefferson, Mahaska, Van Buren, and Wayne Counties.

Table 7 gives the average acre yields and increases due to fertilizer treatment on Grundy silt loam for all fields.

[3] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

TABLE 7.—*Average acre yields of crops and increases due to fertilizer treatment on Iowa experiment fields on Grundy silt loam*

Treatment	Corn [1]		Oats [2]		Hay [3]		Winter wheat [4]	
					Clover, timothy and clover, or timothy			
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*
Check [5]	54.5		41.8		1.47		20.6	
Manure	58.6	4.1	46.6	4.8	1.71	0.24	23.9	3.3
Manure+lime	64.4	9.9	48.9	7.1	1.95	.48	26.4	5.8
Manure+lime+rock phosphate	67.1	12.6	53.0	11.2	2.20	.73	29.9	9.3
Manure+lime+superphosphate	68.6	14.1	57.3	15.5	2.34	.87	30.9	10.3
Manure + lime + superphosphate+ potassium	65.2	10.7			2.32	.85	32.6	12.0
Manure+lime+complete commercial fertilizer	69.8	15.3	56.3	14.5	2.42	.95	28.7	8.1
Crop residues	58.4	3.9	46.8	5.0	1.59	.12	26.2	5.6
Crop residues+lime	62.4	7.9	51.5	9.7	1.85	.38	26.6	6.0
Crop residues+lime+rock phosphate	64.3	9.8	53.3	11.5	2.03	.56	27.1	6.5
Crop residues+lime+superphosphate	63.8	9.3	55.4	13.6	2.05	.58	27.6	7.0
Crop residues+lime+complete commercial fertilizer	63.7	9.2	54.4	12.6	2.09	.62	27.7	7.1

[1] Corn yields averaged from 54 crops on 13 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 21 crops on 7 fields, and the crop-residue plots which are averaged from 33 crops on 6 fields.

[2] Oat yields averaged from 23 crops on 13 fields, except the crop-residue plots which are averaged from 15 crops on 6 fields.

[3] Hay yields averaged from 20 crops on 11 fields, except the crop-residue plots, which are averaged from 11 crops on 5 fields, and the manure+lime+superphosphate+potassium plot which is averaged from 9 crops on 6 fields.

[4] Winter wheat yields averaged from 7 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 3 crops on 2 fields, and the crop-residue plots which are averaged from 4 crops on 3 fields.

[5] The yields given for the checks are the average of the yields on all check plots on all fields.

From data presented in table 7, the value of manure is very evident, showing definite increases in the yields of corn, oats, hay, and wheat. Limestone with manure shows a marked effect on hay yields, this increase being due to the better stands of clover obtained on the sweetened soil. The corn yield has been increased approximately 10 bushels an acre by the use of lime and manure. The effect of limestone on grain yields may be due to the increased growth of legumes, resulting in a greater amount of legume residues which exert an influence on the succeeding crops. When rock phosphate was applied in conjunction with manure and lime, further increases were obtained. Superphosphate under similar conditions had still greater effect in increasing yields. Complete commercial fertilizer with manure and limestone produced about the same results as the superphosphate. Muriate of potash was beneficial to wheat only. Under the grain system of farming, in which crop residues supplied the organic matter, the various fertilizer treatments affected crop yields in the same proportion as when manure was used. The total yields, however, were lower under the grain-farming system.

The data on field experiments on Grundy silt loam in Wapello and Mahaska Counties are given in tables 8 and 9, to show the effects of the various treatments in counties adjoining Monroe County.

TABLE 8.—*Acre yields in field experiment on Agency field,*[1] *series 1, on Grundy silt loa*

Plot no.	Treatment	Corn, 1918 [2]	Oats, 1919	Winter wheat, 1920 [3]	Clover and timothy, 1921 [4]	Timothy, 1922 [4]	Corn	
							1923	1924
		Bushels	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*
1	Check	63.5	44.9	22.7	1.92	2.00	72.7	46.4
2	Manure	64.5	62.2	31.5	2.09	2.20	71.8	51.9
3	Manure+lime	66.8	58.3	36.7	2.20	2.25	79.2	52.2
4	Manure+lime+rock phosphate	68.8	63.6	38.7	2.52	2.30	86.8	54.0
5	Manure+lime+superphosphate	70.0	66.6	40.0	2.39	2.80	85.4	60.2
6	Manure+lime+complete commercial fertilizer	66.0	65.6	34.7	2.52	2.50	83.0	55.4
7	Check	59.3	54.5		1.82	2.30	69.7	43.3
8	Crop residues	58.5	49.0	31.4	1.81	2.20	66.3	43.7
9	Crop residues+lime	61.3	59.5	43.8	2.02	2.40	71.3	50.7
10	Crop residues+lime+rock phosphate	61.8	61.2	36.4	2.33	2.65	73.1	54.9
11	Crop residues+lime+superphsophate	63.5	61.2	36.3	2.19	2.75	80.7	55.5
12	Crop residues+lime+complete commercial fertilizer	62.5	63.6	35.6	2.17	2.65	70.4	54.4
13	Check	52.5	52.0	22.8	1.56	2.40	63.9	42.7

[1] The Agency field was laid out in the fall of 1917, on the Johnson Bros.' farm, northeast of Agency, in Wapello County, R.12 W., T. 72 N.

[2] Corn damaged slightly by hail in July and dry weather in August.

[3] Sample no. 7 lost in transit; wheat badly down. Light dressing of manure to all plots by mistake in winter of 1920. Lim

[4] Pastured after first crop.

[5] Wet weather prevented seeding of plots 11, 12, and 13.

[6] Mostly timothy.

TABLE 9.—*Acre yields in field experiment on Cedar field,*[1] *series 1, on Grundy silt loam, in Mahaska County, Iowa*

Plot no.	Treatment	Corn, 1922	Oats, 1923	Winter wheat		Clover, 1926 [2]	Corn		
				1924	1925		1927	1928	1929
		Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Bushels*	*Bushels*	*Bushels*
1	Check	54.6	39.0	33.0	22.9		73.2	65.7	70.3
2	Manure	50.8	46.0	41.5	24.4		68.3	79.4	62.5
3	Manure+limestone	57.8	54.7	38.7	24.5		72.6	81.3	60.7
4	Manure + limestone + rock phosphate	58.7	46.0	43.0	28.7		72.6	76.6	64.0
5	Check	51.1	40.8	37.6	22.2		66.9	55.3	50.2
6	Manure + limestone + superphosphate	54.9	46.0	40.8	28.2		73.1	71.7	64.9
7	Manure + limestone + superphosphate+potassium	60.3	46.0	42.3	31.2		78.4	69.0	67.7
8	Manure+limestone+complete commercial fertilizer	56.8	42.5	36.8	30.9		60.7	67.4	63.2
9	Check	65.3	38.1	35.2	22.8		62.5	67.8	49.4

[1] The Cedar field was laid out in the fall of 1921, on the farm of W. O. Barnard, north of Cedar, in Mahaska County. The series is located in the NE¼SE¼ sec. 24, R. 15 W., T. 74 N.
[2] Field pastured, no results.

Five fields located on Clinton silt loam showed definite increases after applications of manure. Lime in addition to manure almost doubled the increase over manure alone. Both rock phosphate and superphosphate in conjunction with lime and manure showed crop increases, with greater increases obtained when rock phosphate was used. Similar results were obtained with complete commercial fertilizer treatment as with phosphates alone. The crop-residue plots showed results comparable to manurial treatments but lower total yields.

Average crop yields and increases due to fertilizer treatments on the five Clinton silt loam fields are given in table 10.

TABLE 10.—*Average crop yields per acre and increases due to fertilizer treatment on Clinton silt loam on Iowa experiment fields*

Treatment	Corn [1]		Oats [2]		Hay (clover, timothy and clover, or timothy) [3]		Winter wheat [4]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*
Check [5]	50.6		35.6		1.25		22.9	
Manure	57.1	6.5	41.4	5.8	1.50	0.25	27.9	5.0
Manure+lime	62.3	11.7	50.8	15.2	1.83	.58	31.6	8.7
Manure+lime+rock phosphate	65.8	15.2	54.2	18.6	1.84	.59	35.2	12.3
Manure+lime+superphosphate	63.9	13.3	55.1	19.5	2.00	.75	34.5	11.6
Manure+lime+superphosphate+potassium	61.3	10.7	63.4	27.8	1.96	.71		
Manure+lime+complete commercial fertilizer	66.1	15.5	54.1	18.5	1.99	.74	32.5	9.6
Crop residues	52.5	1.9	46.1	10.5	1.28	.03	23.6	.7
Crop residues+lime	63.4	12.8	46.2	10.6	1.76	.51	27.8	4.9
Crop residues+lime+rock phosphate	66.4	15.8	45.3	9.7	2.06	.81	30.9	8.0
Crop residues+lime+superphosphate	67.9	17.3	50.2	14.6	2.02	.77	29.4	6.5
Crop residues+lime+complete commercial fertilizer	69.4	18.8	49.2	13.6	2.05	.80	32.3	9.4

[1] Corn yields averaged from 13 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 7 crops on 3 fields, and the crop-residue plots, which are averaged from 6 crops on 2 fields.
[2] Oat yields averaged from 7 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 4 crops on 3 fields, and the crop-residue plots, which are averaged from 3 crops on 2 fields.
[3] Hay yields averaged from 8 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 5 crops on 3 fields, and the crop-residue plots, which are averaged from 3 crops on 2 fields.
[4] Winter wheat yields averaged from 3 crops on 2 fields, except the crop-residue plots, which are averaged from 2 crops on 1 field.
[5] The yields given for the checks are the average of the yields on all check plots on all fields.

The Princeton field on Clinton silt loam in Scott County was laid out in 1918. The average yields of the various crops under different fertilizer treatments are given in table 11.[4] The records show yields from 1918 to 1929, inclusive.

TABLE 11.—*Acre yields in field experiment on the Princeton field, series 1, on Clinton silt loam, in Scott County, Iowa*

Plot no.	Treatment	Winter wheat, 1918 [1]	Corn		Oats, 1921	Clover, 1922 [4]	Corn, 1923
			1919 [2]	1920 [3]			
		Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Bushels*
1	Check	40.7	69.3	61.8	27.7	1.41	54.0
2	Manure	37.4	67.6	68.3	28.4	1.93	63.2
3	Manure+limestone	43.0	68.2	70.6	32.1	2.13	70.2
4	Manure+limestone+rock phosphate	47.4	67.8	73.5	31.9	2.25	72.5
5	Manure+limestone+superphosphate	45.2	64.0	70.8	35.1	2.29	73.2
6	Manure+limestone+complete commercial fertilizer	37.3	68.4	73.0	36.4	2.34	68.1
7	Check	31.7	57.0	57.5	24.4	1.60	53.0
8	Crop residues		52.6	58.6	29.6	1.47	55.2
9	Crop residues+limestone	31.7	62.4	67.3	29.7	2.14	61.8
10	Crop residues+limestone+rock phosphate	35.0	64.1	68.7	29.8	2.28	65.0
11	Crop residues+limestone+superphosphate	31.7	66.6	61.5	31.1	2.18	68.0
12	Crop residues+limestone+complete commercial fertilizer	36.2	65.2	69.5	30.8		70.1
13	Check	28.2	59.3	59.5	25.5		58.6

Plot no.	Treatment	Oats, 1924	Winter wheat, 1925 [5]	Clover, 1926	Corn		Oats, 1929 [6]
					1927	1928	
		Bushels	*Bushels*	*Tons*	*Bushels*	*Bushels*	*Bushels*
1	Check	65.8	13.6	0.96	67.8	64.6	46.5
2	Manure	64.8	22.6	1.57	79.7	72.7	74.9
3	Manure+limestone	65.3	27.5	2.06	97.3	74.2	70.2
4	Manure+limestone+rock phosphate	63.1	32.1	2.08	96.4	76.4	71.3
5	Manure+limestone+superphosphate	75.1	31.8	2.31	86.9	79.2	69.2
6	Manure+limestone+complete commercial fertilizer	71.9	32.4	2.15	89.8	80.7	75.0
7	Check	62.2	16.9	.73	59.7	50.3	39.7
8	Crop residues	66.4	15.5	.72	57.4	52.2	44.3
9	Crop residues+limestone	65.6	23.8	1.35	78.4	66.6	60.1
10	Crop residues+limestone+rock phosphate	63.4	26.7	2.06	81.3	69.8	56.8
11	Crop residues+limestone+superphosphate	75.1	27.1	2.03	89.0	74.4	41.9
12	Crop residues+limestone+complete commercial fertilizer	73.5	28.3	2.25	83.8	74.5	68.1
13	Check	54.4	17.5	.98	64.0	54.4	52.1

[1] 3 tons lime applied in August 1917. Yield on plot 8 an error.
[2] Clover poor and plowed up.
[3] Plot 11 many missing hills, low yields.
[4] Yields on plots 12 and 13 lost because of error.
[5] Stand of wheat very thin owing to extremely dry spring.
[6] Oats down badly on plots 3, 4, 5, 10, 11, and 12.

Results obtained on this field indicate the value of manure and limestone, especially on the legume crop. The increased legume growth, in turn, influences the yield of the succeeding grain crops, by supplying organic matter and available nitrates. Phosphates further increase all crop yields, with superphosphate giving slightly greater increases than rock phosphate. Complete commercial fertilizers give slightly greater increases than either of the phosphates.

Monroe County is a member of the first Four-County Soil Improvement Association organized in Iowa. The four counties—Monroe,

[4] STEVENSON, W. H. and BROWN, P. E., with the assistance of BENTON, T. H., MELDRUM, H. R., FORMAN, L. W., and BENNETT, R. E. CLAYTON COUNTY SOILS. Iowa Agr. Expt. Sta. Soil Survey Rept. 65, 72 pp., illus. 1930.

Mahaska, Wapello, and Appanoose—are under the direct supervision of a field man trained in soil-improvement methods. From his headquarters at Albia, he conducts and directs experiments on farms to improve crop land, control erosion on all types of land, and studies methods to improve pastures. The work is of such recent date that no results which could be given at present could be regarded as typical of those which may be expected for a series of years. The principal accomplishments include the terracing of many fields to prevent erosion, control of gullying by tree planting, establishing alfalfa test plots to prove that this legume can be successfully grown on well-limed soil, and conducting experiments to prove the value of commercial fertilizers on the principal types of crop land. Additional records and data obtained in the near future will undoubtedly be of great value to the agriculture of Monroe County.

The Iowa system of soil management includes five distinct steps which, if followed, may be expected to increase crop yields and profits, as well as to maintain the soil fertility. They are (1) drainage and cultivation, (2) manuring and green manuring, (3) liming, (4) the use of phosphates and other fertilizers, and (5) rotation of crops.

Proper drainage conditions must exist before a soil can produce crops to its maximum capacity. The greater part of the land within Monroe County is hilly and requires no artificial means to remove excess moisture. In most places, precautions must be taken to prevent rapid run-off and the resultant washing of the fields. Cropping methods whereby the entire slope is not planted to a cultivated crop at one time greatly reduces soil loss from erosion. Strips of meadow or small grains between cornfields on slopes prevent sheet wash. Terracing the slopes prevents the rapid run-off of surplus water and naturally allows more time for the water to seep into the soil, to be used later by the growing plants. Some areas occur where artificial drainage would greatly improve the soil, such as the broad flats on the upland divides and the low level terraces. The character of the subsoil layers of much of this land hinders the movement of soil moisture, and this, in conjunction with the flat relief, greatly reduces the efficiency of the soil to produce crops. In normal seasons yields are good, but in wet seasons there are noticeable decreases.

Good drainage promotes good aeration which, in turn, shows its beneficial effect on crops by supplying a greater quantity of available plant nutrients, because of better oxidation and greater bacterial activity. Tiling wet fields allows earlier working in the spring and following rains during the growing season, and it transforms water-logged soils into excellent crop land. In draining the soils of this county, the tile lines must be laid close together, as the drawing power of tile in the heavy subsoils is limited to short distances. Tile should be first covered with broken tile, stones, gravel, or cinders, and the black surface soil placed in the trench first to insure against the tile clogging with the fine clay soil particles.

Proper cultivation of crops planted on well-plowed and well-prepared seed beds produces increases in crop yields. Control of weeds, which compete with the crop for moisture and plant nutrients, is well understood, as are also the advantages of deep plowing and clean cultivation.

The light color of many of the soils indicates a lack of organic matter. This is best supplied by barnyard manure, crop residues,

such as cornstalks and straw, and green manures, preferably legumes. Few farms have sufficient barnyard manure to treat the fields regularly at the rate of 8 tons an acre once in a 4-year rotation, and an additional supply of organic matter must be obtained from other sources. Legumes, such as red clover, alsike clover, and sweetclover, are excellent green-manure crops. If possible, the entire crop should be plowed under where fields are decidedly deficient in humus, but the second crop should always be plowed under, as every soil is deficient in active humus, and additions by means of manure or green manure invariably increase crop yields.

The soils of Monroe County are extremely acid in reaction in both the surface and subsoil layers, except that some areas of Shelby silt loam and Lindley silt loam may contain lime in the subsoil, but where this condition exists the surface relief prevents cultivation and the fields are so badly eroded they are regarded as waste land. All tillable land shows the need of lime. The degree of acidity ranges from medium to strong, and the land requires from 2 to 5 tons of limestone an acre to correct the acidity. All crops grow well in the presence of lime, but some crops, especially legumes, require a sweet soil and the presence of lime before they can be successfully grown. Soybeans and red clover are not so sensitive to soil acidity as are alfalfa and sweetclover. The last-mentioned legumes require a sweet soil and refuse to grow under conditions where this element is lacking. Stands of sweetclover and alfalfa have been obtained on small fields which are very fertile and heavily manured, but it is generally understood that satisfactory stands cannot be obtained on an acid soil. Sweetclover and alfalfa are ideal crops to grow on those soils having heavy clay subsoils, as the roots of these plants penetrate deeply into the subsoil, and when the plants die or are plowed under, the roots decay rapidly, leaving a channel for moisture to escape through the heavy layer to the lighter textured lower subsoil layer and in addition allowing better aeration of the subsoil. Observations, during the field season, of fields formerly in sweetclover, prove that better drainage results, and a much better seed bed, which is mellow, even, and in good physical condition, follows a crop of sweetclover. Liming and growing sweetclover on the level poorly drained areas are highly recommended and are sure to increase crop yields.

Field tests with different phosphate fertilizers generally show good results. Analyses made of the soil samples of the soils within the county show a low phosphorus content, but the value of fertilizers may best be determined by tests made on different crops on the individual farm. If crops respond economically to phosphate fertilizers, their use may be adopted. Clovers usually show a marked increase in growth following phosphate treatment. On many farms failure to obtain a stand of clover is due to the lack of phosphate and deficient organic matter. The field experiments previously discussed show the effect of different fertilizers on the main soil types.

The last-named essential practice in soil-improvement methods is the rotation of crops. Continuous cropping of land quickly depletes the soil of nutrient elements. Fields become difficult to handle, the soil clods easily, and crop yields are low. No soil type within the county can withstand continuous cropping without detrimental effects. Tillable land, being at a premium because it is limited in acreage, has been subjected to heavy cropping for several decades,

and many farms are now abandoned, in part owing to continuous cropping and their resultant lower productivity. To prevent increasing the number of such farms, those in operation should be placed under a regular rotation system and procedures adopted to place them on an economically sound producing basis. Those badly run down can best be brought back by following a 3-year rotation of corn, oats, or other small grain and clover, the entire clover crop to be plowed under in the first two rotations and the second crop in each succeeding rotation. Four-year rotations of corn, oats, and clover maintain the soil fertility at a constant level, and by using phosphate fertilizers with the 4-year rotation, greater increases may be expected. When alfalfa is included in the rotation, it occupies the land for 4 or 5 years. The size of the farm and the shape of the fields may determine in part the particular cropping system to be followed. Any method whereby the continuous cropping of a field is eliminated will prove of value in a soil-improvement program.

More than one-half of the county is pasture land, and a large proportion of the land now cultivated is best adapted to pasture grasses. Cattle production, to which the county is well adapted, has declined materially within the last 5 years, and hogs have replaced cattle on many farms. The land suitable for corn has been unable to supply the farm need, and through necessity much land formerly regarded as unsuitable for tilled crops is now under the plow. With thousands of acres of excellent pasture land, or land which may be converted into good pastures by improvement practices, an increase in cattle production may be expected. Either beef-cattle raising or dairy-farming methods can make more efficient use of the land. The rougher areas, which support only a meager grass growth but an abundant supply of other feed which sheep consume, could well be devoted to sheep ranches. The tillable land on each farm would no doubt produce sufficient grain to keep the animals in condition during the winter, and a small acreage of alfalfa would provide excellent roughage for the winter months. Cattle carried through the winter on alfalfa hay and a small quantity of grain, which can be grown on the farm, would be in much better condition than those wintered under many methods now in practice.

In recent years soybeans, grown either for hay or seed, have been introduced. This crop has gained popularity because of the seemingly profitable yields that could be obtained on the acid soils, but their cultivation has resulted in increased erosion. Soybeans are best suited to level areas where washing is negligible, but this factor was not always considered and they have been planted on all types of land, ranging from level to hilly. Soybeans have the ability to loosen the upper 2 or 3 inches of soil material, converting it into almost a dust mulch, and, when the crop is removed, the barren fields with this mulch on the surface are exposed to the action of run-off water during rains. Sloping fields wash readily, and, after the removal of the surface material, only a thin covering remains over the clay subsoil. The profit received from the crop may be transformed into a heavy loss when the damage to these fields is considered.

In removing timber from land, several facts should be considered. Careless cutting results in transforming valuable woodland pasture to worthless pasture land, as sprouting stumps soon crowd out undergrowth and lower the pasture value, and the cost of clearing such land

greatly exceeds its original value. If the land is not to be cleared by the removal of stumps but is to be utilized for pasture, the stumps should be cut high to prevent sprouting as much as possible. Under all conditions stump sprouts should be controlled, otherwise the land will soon become worthless.

For further information on the Iowa system of soil management, the reader is referred to Iowa Agricultural Experiment Station Bulletin 213.[5] Field experiment results may be obtained from Iowa Agricultural Experiment Station Bulletins 269 [6] and 280,[7] and the soil survey reports for the various counties surveyed prior to 1930.

SOILS AND THEIR INTERPRETATION

Monroe County lies wholly within the southern Iowa loess area. It is characterized by an intricate drainage system which has greatly influenced the soil-forming processes and the resultant soil. A large part of this drainage system was established over the original level Kansan drift plain before deposition of the mantle of silty material, or loess, took place. The master streams, together with their secondary systems, rapidly cut back into the surrounding uplands. The finger-like tertiary drainage system cut still farther back into the uplands, leaving the characteristic rolling and hilly surface relief, and only comparatively narrow level divides now remain between the numerous drainage courses to mark the original plain level. The mantle of loess covering the glacial till when deposited differed in thickness, ranging from 4 to 15 feet. After its deposition erosion again became active. Stream cutting and invasion have so thoroughly progressed that every square mile is supplied with drainage outlets to conduct the surplus moisture to the master streams. Vegetation obtained a foothold and soil-forming processes normally progressed under different local conditions.

In general, the soils were formed under prairie grasses on smooth areas with either adequate or poor drainage of both surface and subsoil layers, and under a timber growth in well-drained or excessively drained areas. The silty texture of the surface soil, or A horizon, predominates over the entire county, and it is only in those areas where the slopes are eroded that the glacial till, which underlies the whole county, comes sufficiently close to the surface to affect the texture by increasing the percentage of sand. The lower soil layers are predominantly heavy. The high clay content, resulting in a compact and impervious B horizon, retards the internal movement of soil moisture. The parent materials from which the soils have been derived are everywhere decidedly lighter in texture than the overlying B horizon.

The soils of the nearly level divides have restricted drainage either on the surface or internally, and in many places both, therefore the soil profile cannot be considered as developed under normal conditions. The soils of the level prairie area have dark-colored surface layers, owing to the high content of organic matter which has accumu-

[5] STEVENSON, W. H., and BROWN, P. E. THE IOWA SYSTEM OF SOIL MANAGEMENT. Iowa Agr. Expt. Sta. Bull. 213, pp. 289–318, illus. 1923.

[6] STEVENSON, W. H., BROWN, P. E., FORMAN, L. W., MELDRUM, H. R., ENGLEHORN, A. J., and BENNETT, R. E. FIELD EXPERIMENTS WITH FERTILIZERS ON SOME IOWA SOILS. Iowa Agr. Expt. Sta. Bull. 269, pp. 165–202, illus. 1930.

[7] STEVENSON, W. H., BROWN, P. E., FORMAN, L. W., MELDRUM, H. R., ENGLEHORN, A. J. and BENNETT, R. E. A SOIL-MANAGEMENT PROGRAM FOR GRUNDY SILT LOAM. Iowa Agr. Expt. Sta. Bull. 280, pp. 165–186, illus. 1931.

lated and become an integral part of the upper layers through decay of the prairie-grass roots. Drainage conditions greatly influenced the accumulation of this organic material, the poorly drained level areas having thicker dark A horizons, the thickness decreasing with the establishment of better drainage. The dark color may extend to a depth of 16 inches, and dark organic streaks may extend as deep as 40 inches into the lower horizons. Animal burrows and cracks within the lower layers, caused by shrinkage during dry periods, allow the fine dark organic material to seep downward with each additional supply of moisture. The B horizon is extremely heavy drab material heavily stained with iron. The structure of this claypan is prismatic. The faces of the irregular-shaped blocks appear to be coated with a gelatinous colloid which is a greasy, yet sticky, substance, generally brown or black. Below the zone of maximum compaction, the soil material becomes lighter textured, gray is the basic color, and streaks or stains from iron oxide are less numerous than in the overlying horizon. The parent material is gray compact silt loam. Soils having this profile are classed in the Grundy series.

Following is a description of a profile of Grundy silt loam, as observed in a pit along State Highway No. 59, in sec. 26, Bluff Creek Township. This profile is representative of the Grundy soils as they occur in Monroe County.

From 0 to 1½ inches, the material consists mainly of grass roots in all stages of decomposition, from the fresh plant root to finely divided humus. The mineral content is dark grayish brown in color and silty in texture. All the soil particles are small firm granules which, when crushed, are lighter colored than when unbroken.

From 1½ to 12 inches, dark grayish-brown friable silt loam, the upper 2 inches of which are faintly laminated, but the remainder is distinctly granular. All the soil granules are slightly larger than those of the grass-root horizon above, ranging from one-sixteenth to one-eighth inch in diameter. Grass roots penetrate the entire layer and cling tightly to the soil granules when the mass is shaken. The material in this layer is thoroughly worm worked. The gray color imparted to the soil mass occurs as a thin coating around the granules, disappearing when they are crushed. The soil is dark brown when moist.

From 12 to 18 inches, slightly heavier and lighter colored material which consists of a mass of rounded granules larger than those in either of the overlying layers. The undisturbed mass is grayish brown, but it crushes to brown. The gray coating covering the granules is more pronounced in this layer. A few grass roots penetrate the entire layer, clinging firmly to many granules when pulled from the mass, and a few faint iron stains are present at the base of the layer.

From 18 to 26 inches, a transitional zone of light silty clay loam which is yellowish brown when crushed. The entire mass consists of coarse hard granules which appear to be dark brown on the outside and yellowish brown within. Iron staining increases with depth.

From 26 to 29 inches, a layer of silty clay, the basic color of which is drab, and mottlings of gray, brown, and yellowish brown are predominant. The structure is prismatic, and on drying the soil material breaks out in large blocks. The cleavage joints between the soil prisms are filled with what appears to be a colloidal substance, greasy but very sticky when on the fingers. Some dark organic material has gained entrance to this horizon by seeping downward along cleavage planes or cracks formed during droughty periods. The mass is heavily iron stained, but no hard concretions have been formed.

From 29 to 40 inches, the basic color is dark gray or slate gray, with mottlings of yellowish brown, iron stains, and various colors evident. This silty clay loam mass has no definite structure. A few hard iron concretions are present.

From 40 to 63 inches, light silty clay loam which is predominantly gray, with yellowish-brown and rust-brown streaks throughout. Many fine

dark streaks extend throughout this layer, most of them horizontal but others extending in all directions. Vertical streaks of organic colloidal material extend through the entire layer, gaining entrance possibly through old root channels, worm or insect burrows, or cracks. This colloid is sticky and adheres to the fingers as a thin dark coating.

Below a depth of 63 inches, the parent material, from which the soil has been derived. It is gray, with staining and splotching of yellowish brown throughout but not so pronounced as in the overlying layers. Numerous fine pinholes and small black streaks occur throughout this structureless compact silt loam material. No lime carbonates are present to a depth of 8 feet.

Grundy silt loam occurs on the broad upland divides throughout the entire county. The soil profile is not uniform over the area of its occurrence and may differ in the thickness of the dark surface layer, in the intensity of gray coating on the granules, and in the color of the lower layers.

Where the prairies were level or slightly depressed, conditions of excessive moisture have developed a soil profile differing from that of the Grundy soils. The dark surface layer is similar but may be slightly heavier in texture and somewhat thicker. Beneath the dark surface horizon is a thin layer of gray or white floury compact silt loam. The remaining horizons are almost identical with those of the Grundy soils. The dark-colored soils underlain by gray silty layers are classified as Edina silt loam on the loess-covered upland and Chariton silt loam on the terraces. Closely resembling Edina silt loam is Putnam silt loam which differs from the Edina soil only in having a lighter colored surface layer, which in most places is grayish brown in color, and in having a heavier more compact horizon beneath the gray silty layer. The Marion soils differ from both the Edina and Putnam soils in that they have light-gray or almost white surface soils, and the gray silty layer rests on the claypan horizon.

A profile of Edina silt loam, as observed in a pit dug in a clover and timothy field in sec. 10, T. 71 N., R. 17 W., near Selection, shows the following layers:

From 0 to 2 inches, dark grayish-brown faintly laminated silt loam thoroughly filled with plant roots. The soil material breaks down into an imperfectly granular mass with some fine dustlike material not included in the aggregates.

From 2 to 9 inches, very dark grayish-brown mellow silt loam which is faintly laminated or imperfectly granulated but almost structureless. Crushed material shows but little change in color.

From 9 to 12 inches, a transitional layer in which the material consists of very dark grayish-brown silt loam, with a sprinkling of gray in the upper part and more pronounced gray coloring in the lower part. On crushing, the color undergoes a decided change to dark brown. In place, the material is faintly laminated, but when disturbed it breaks down into irregular structure particles that are coated with gray.

From 12 to 21 inches, the characteristic gray layer of the Edina soils. The broken surface of this material is gray which in most places changes to dark brownish gray when the soil is crushed. This floury silt loam is very friable and shows a faintly laminated structure, but it breaks down into angular structure particles about one-fourth inch in diameter.

From 21 to 30 inches, compact silty clay which represents the zone of maximum compaction. Vertical cracks, probably designating true columnar structure, extend through the entire compact layer. The broken surface is dark, almost black, with some discoloring of yellow and gray. A sliced surface across the structure particles shows the typical Grundy coloration of dark grayish brown, gray, and rust brown. The material has indistinct structure particles but does not fall apart into a granular mass as does the corresponding layer of the Grundy soils. The largest extent of the black color is along the cracks, the surfaces of which have

a black shiny appearance and are evidently covered by a film of organic colloids seeped in from above. The centers of the structure particles appear to be iron oxides. Many spots of iron segregation and soft iron concretions are scattered throughout the material.

From 30 to 46 inches, the basic color of this structureless plastic silty clay layer is gray with mottling of brown, yellow, and rust brown. The dark color is caused by infiltration of organic matter from above, through cracks. The iron is segregated into larger bodies than in the layer above, with numerous concretions attaining a size of one-fourth inch in diameter scattered throughout the layer. The material is less tough and plastic than that immediately above, and it becomes more friable with depth.

From 46 to 64 inches, the material in the upper part of the layer is similar to that in layer 6, but it becomes more gray with depth, and iron accumulations are less numerous.

From 6 to 83 inches, grayish-yellow plastic silty clay loam which becomes increasingly silty with depth. Iron segregations have almost completely disappeared in this structureless material.

Edina silt loam is closely associated with Grundy silt loam, in all places being completely surrounded by the Grundy soil. It occurs in level or depressed areas on the broad, flat prairies where drainage is inadequate. In total acreage it ranks as a minor soil type, but the numerous developments occurring within Grundy areas are readily discernible by their effect on crop growth and cultural practices.

As the drainageways began to cut back from the main channels and extended into the upland plains, the water table was lowered, resulting in better internal drainage. The rolling relief favored the rapid run-off of excess moisture. With decrease of the moisture content, the soils became better aerated. This led to greater oxidation of the entire soil and a changing of its characteristics. Erosion in many areas was extremely rapid, removing the easily movable fine silty material and carrying away the humous material as fast as it could form. Under these conditions a soil developed having a thin dark surface layer with a yellowish-brown heavy subsoil which, in turn, rested on the silty parent material. Hazelbrush, buckbrush, and other shrubs invaded this part of the upland, decreasing the grass growth and thereby cutting off a part of the humus supply. The result was the development of a soil having a lower content of organic material than those on the level plains, and consequently a lighter color. As the steepness of the slope increased, erosion became more pronounced, resulting in the removal of the greater part of the silty covering. Under these conditions, the Kansan till was brought near the surface. With still further betterment of drainage conditions, the type of vegetation changed, and trees established themselves in the better drained areas near the streams, finally year by year encroaching on the upland plain farther back from the main stream. Under a heavy tree growth, prairie grasses failed to thrive, the source of organic material was cut off, and the existing humus soon disappeared, leaving the light-colored typical forest soil. The lower layers are yellowish brown and are derived either from the loess or the Kansan till.

The following description of a profile of Clinton silt loam, observed 1½ miles southeast of Lovilia, is representative of the light-colored soils on rolling areas.

The grass-root layer extends to a depth of about 1 inch in Clinton silt loam. The mineral part of the soil material is gray or dark-gray fine silt loam. No definite structure has developed, but the particles are massed in soft irregular aggregates, although not a large percent-

age of fine silt is included in these soft aggregates. In this location moss was growing on the immediate surface in shaded areas. The second layer from the surface downward consists of brownish-gray friable smooth silt loam to a depth of 7 inches. The upper part shows a soft granular structure, and the lower part shows a faintly developed platy structure, owing to compactness. Between depths of 7 and 13 inches is pale yellowish-brown and gray structureless heavy silt loam. The mass breaks down into soft clods which are coated with gray and the inner parts of which are yellowish brown. From a depth of 13 inches and extending to a depth of 19 inches, the material is dark yellowish-brown silty clay loam which consists of coarse granules heavily coated with gray. Each granule is hard, angular, and distinctly developed. When the granules are crushed, the material becomes light yellowish brown. The fifth layer from the surface, between depths of 19 and 25 inches, is yellowish-brown and gray compact heavy clay. This is the heaviest layer of the Clinton silt loam profile. No distinct structure has developed. Beneath this heavy clay, and continuing to a depth of 46 inches, is gray and brown silty clay loam. Gray is the predominant color, but both colors are well developed. Some iron segregation is noticeable in this structureless mass. Below a depth of 41 inches is the parent material, a gray and yellow structureless heavy silt loam which is not greatly different from the material immediately above it. The lime carbonate has been thoroughly leached from the entire soil mass.

Clinton silt loam occupies the narrow rolling divides, ridge tops, and upper slopes in the heavily wooded sections of the county, where dense tree growth hindered the growth of grasses, thereby cutting off the source of organic matter. The thickness of the surface layer differs, and many of the cultivated fields and denuded hillsides have become so thoroughly eroded that the yellow clay outcrops.

The following description is of a profile of Marion silt loam 2¾ miles southeast of Tyrone. It is representative of a light-colored soil developed on the narrow flat-topped ridges within the heavily wooded sections of the county. Natural drainage is poor because of the flat surface and heavy lower layers. This is one of the few level upland soils covered by dense timber rather than the common prairie-grass growth.

The upper inch of Marion silt loam, as observed in a roadside cut, is composed mainly of fine grass roots forming a turf. The mineral part of this layer is light brownish-gray fine silt loam, in which faint lamination has developed, and some of the material has collected into small soft balls. In cultivated fields numerous small iron pellets are scattered over the surface. The material between depths of 1 and 6 inches is light brownish-gray floury silt loam. The mass consists of a series of small plates giving a distinct laminated structure. These plates are more gray on the surface than in their centers. An increasing number of small iron pellets gives the soil material a gritty feel. The third layer is the characteristic gray or ash-colored layer occurring in all Marion soils, and it consists of floury or ashy compact silt loam material, almost as fine as talc, which is gray or almost white and heavily stained with brown and rust-brown iron oxides. A cut surface reveals an average of about 55 iron pellets a square inch of surface. A faint laminated structure has developed, but, when disturbed, the material breaks down into soft crumblike balls. This layer is easily distinguishable because of the abruptness of the change

both from the layers above and those below. Between depths of 10 and 15 inches, the material is dark-drab and light-gray nut-structured silty clay loam. Drab is the basic color, with gray present as a coating around the soil aggregates, although in a few soil aggregates the gray color has penetrated to the inner parts. Iron pellets are much less numerous than in any of the overlying layers. The soil aggregates dry very hard, have sharp edges, and are of all shapes, ranging from cubes to wedges. The fifth layer consists of dark-drab heavy compact impervious clay which is plastic when wet and very hard when dry. This is the zone of maximum compaction. The material is structureless, but on drying it forms large blocks with the most noticeable cleavage planes lying in a vertical position, suggesting a columnar structure. The horizontal cracks are irregular. A sliced surface reveals the presence of iron concretions but shows no change in color. Between depths of 22 and 36 inches the material is dark yellowish brown and gray stained with rust brown and black. The texture is silty clay, and though not so heavy and dense as that in the layer above, it is not greatly different except in the increasing amount of yellow color. Below a depth of 36 inches is gray, mottled and streaked with yellowish brown and rust brown, silty clay loam. The gray color and lighter texture increase with depth, but the iron staining decreases in intensity. At a depth of 60 inches the gray silt loam parent material is present in an almost unweathered state.

The alluvial deposits of the county are mainly first-bottom soils subject to more or less overflow. Streams have cut deep channels through the county, but each valley is comparatively narrow and but few terraces have been formed. For the most part, the alluvial soils are dark-colored soils with heavy subsoils. The first-bottom soils are all classed in the Wabash series. The most extensively developed terrace soils have extremely heavy subsoils and occur on level benches well above overflow.

In the northeastern part of the county, coal shale outcrops on practically all the slopes. The thin soil developed over this has been classified as Dubuque silt loam.

Table 12 gives the results of pH determinations of several soils of the county. These values were determined in the laboratories of the Bureau of Chemistry and Soils by E. H. Bailey, using the hydrogen-electrode method.

TABLE 12.—*pH determinations of several soils from Monroe County, Iowa*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Grundy silt loam:	*Inches*		Weller silt loam:	*Inches*	
338209	0 – 1½	6.40	338253	0 – 1½	5.98
338210	1½–12	6.65	338254	1½– 5	6.13
338211	12 –18	5.94	338255	5 –10	5.80
338212	18 –26	5.80	338256	10 –15	5.89
338213	26 –29	5.80	338257	15 –21	5.57
338214	29 –40	6.15	338258	21 –41	6.32
338215	40 –63	6.49	338259	41+	6.98
338216	63+	7.17			
Putnam silt loam:			Shelby silt loam:		
338224	0 – 1½	6.40	338260	0 – 2	6.07
338225	1½– 9	6.67	338261	2 – 5	6.15
338226	9 –16	5.96	338262	5 – 9	5.69
338227	16 –18	5.22	338263	9 –17	5.49
338228	18 –31	5.65	338264	17 –26	5.87
338229	31 –43	6.00	338265	26 –50+	8.49
338230	43 –60	7.20			
338231	60+	7.20	Waukesha silt loam:		
			338274	0 –16	6.59
			338275	16 –24	6.57
			338276	24 –45	5.55

SUMMARY

Monroe County is in the southern part of Iowa and has an area of 432 square miles. Albia is the county seat and largest town.

The entire county is well drained by a dendritic system of creeks and small tributaries. Most of the drainage is east and north into Des Moines River which crosses the extreme northeastern corner.

The elevation ranges from 1,000 feet on the main divide at the southern county line to 677 feet along Des Moines River in the northeastern corner.

Railroads furnish ample transportation facilities, and two paved highways cross the county. County and township roads are of earth construction but are kept in good repair, well graded, and dragged.

Schools and churches are located in the towns and villages.

Coal mining at one time was an important industry, but at present only a few mines are operated.

The climate is healthful and well suited to growing all crops common to the Corn Belt. The rainfall is ample and well distributed throughout the year.

Corn, oats, and hay are the principal crops grown, and these three crops generally occupy about 40 percent of the farm land each season.

All the farming operations are based on the growing of these feed crops, especially corn, which is grown as often as possible on all farms. Many farms have been so much overcropped to corn that the fertility of the land has been badly depleted, and much land has been abandoned for cropping and allowed to grow up to brush and weeds. Much woodland and cut-over land, if sprouts and tree growth were properly controlled, could be converted into valuable pasture land. The county as a whole is well adapted to livestock, especially the raising and feeding of beef cattle. Dairying is also a source of considerable cash income.

Hog raising and fattening is the principal livestock industry in recent years, and most of the corn and other feed crops are used in preparing the hogs for market.

Poultry raising is a source of considerable income on many farms. Baby chicks are purchased from commercial hatcheries, fed until they weigh from 2½ to 3 pounds, and then sold. Some laying flocks are maintained and the eggs marketed.

Some fairly large flocks of sheep and goats are pastured in the rougher sections and on cut-over land that has grown up so thickly with sprouts and young trees that grass cannot succeed.

Very little commercial fertilizer is used. The use of limestone to grow alfalfa and sweetclover has increased in recent years, and some phosphates are used on cornland.

Most of the farms are operated by the owners, and most of the tenant farms are operated on a share basis, the crops being divided equally and the tenant paying cash for the pasture land.

The soils have been divided into three groups—general-farming soils, small-grain and hay soils, and pasture soils.

The general-farming soils comprise the dark-colored well-drained soils. The extent of these soils in any part of the county largely determines the type of agriculture engaged in and the crops grown,

as these are the important crop-producing soils and are adapted to growing all the crops commonly produced.

The small-grain and hay soils are better adapted to growing small grains and hay than corn, but on many farms they constitute the principal crop soils, and corn must, of necessity, be grown on them.

The pasture soils are used almost exclusively for pasture, although they do not include all the permanent pasture land on the farms. Lindley silt loam and Dubuque silt loam are extremely rough and heavily forested and cannot be successfully cropped. Wabash silt loam and river wash are subject to such frequent overflow that most crops are destroyed before maturity.

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Washington, D.C. 20250-9410;

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(3) email: program.intake@usda.gov.

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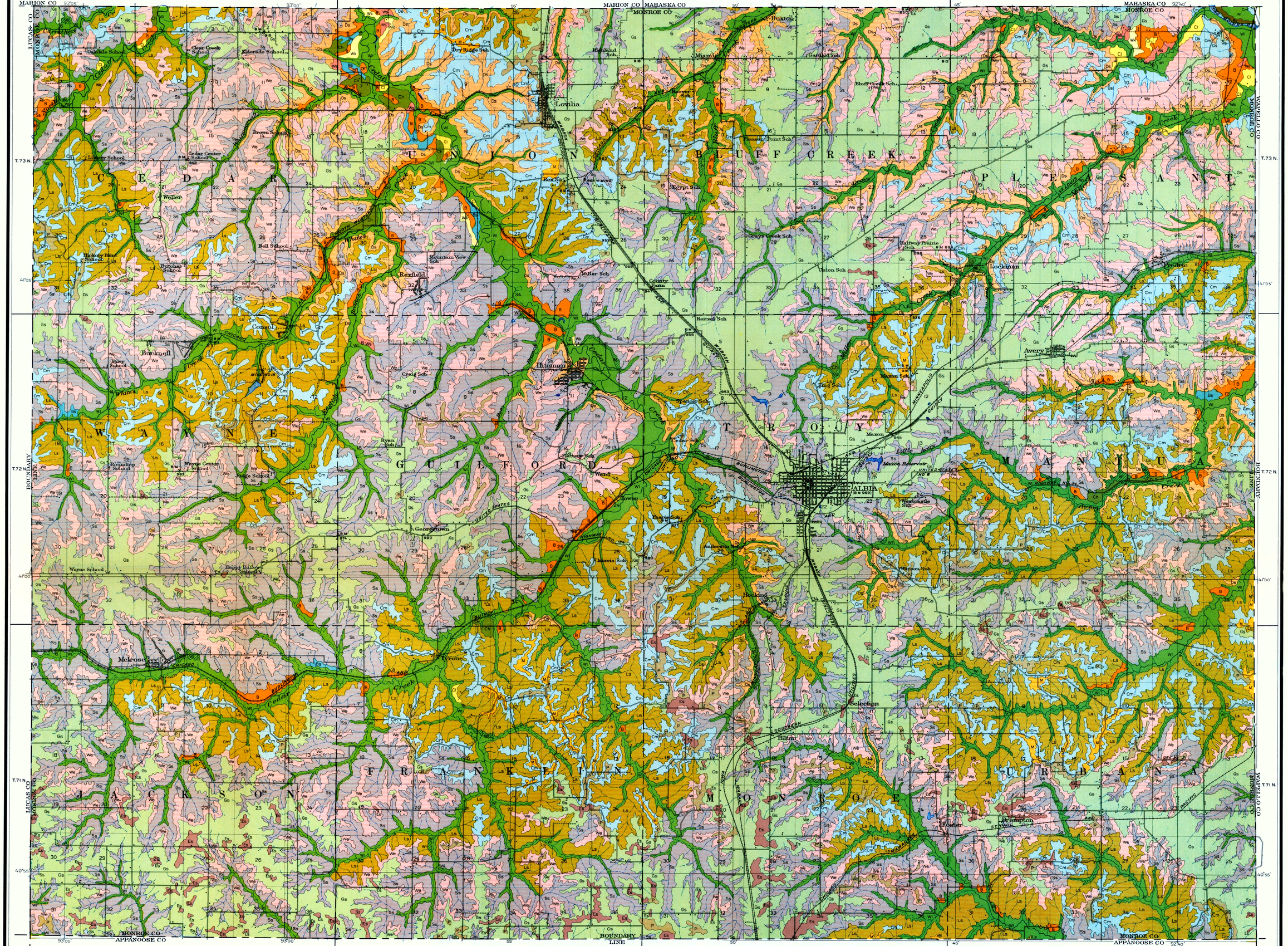
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
MONROE COUNTY
IOWA

IOWA AGRICULTURAL EXPERIMENT STATION
R. E. BUCHANAN, DIRECTOR
P. E. BROWN, IN CHARGE SOIL SURVEY



LEGEND

- Bremer silt loam (B)
- Marion silt loam (M)
- Bremer silty clay loam (Bs)
- O'Neill fine sandy loam (Or)
- Calhoun silt loam (Cl)
- Putman silt loam (P)
- Chariton silt loam (Ch)
- Shelby silt loam (Ss)
- Clinton silt loam (Cm)
- Wabash silt loam (Wl)
- Dubuque silt loam (Ds)
- Wl — Colluvial phase
- Edina silt loam (Es)
- Waukesha loam (Wk)
- Grundy silt loam (Gs)
- Waukesha silt loam (Ws)
- Lindley silt loam (Ls)
- Weller silt loam (We)
- River wash (Rv)

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
- Secondary roads and Trails
- Railroads Steam and Electric
- Bridges, Ferry
- R.R.crossings, Tunnel
- Ford, Dam
- School or Church Cemeteries
- Mine or Quarry Mine dumps Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines
- Boundary lines
- Boundary lines
- U.S township and section lines

DRAINAGE
(Printed in Blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp Salt marshes
- Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Thomas D. Rice, Inspector, District 3.
Soils surveyed by C. L. Orrben, Iowa Agricultural Experiment Station, in charge, and W. E. Tharp, U. S. Department of Agriculture.

BASE MAP IN PART FROM
U. S. GEOLOGICAL SURVEY SHEETS

Scale 1/62500
1 0 1 2 3 4 Miles
1 0 1 2 3 4 5 Kilometers

Field Operations
Bureau of Chemistry and Soils
1931